

# APEX WASTEWATER TREATMENT PLANT

DRAFT PRE-DESIGN REPORT

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POGGEMEYER  
DESIGN GROUP

**PREPARED FOR:**

CITY OF NORTH LAS VEGAS  
2250 LAS VEGAS BLVD., NORTH  
NORTH LAS VEGAS, NV 89030

**PREPARED BY:**

POGGEMEYER DESIGN GROUP, INC.  
6960 SMOKE RANCH ROAD  
SUITE 110  
LAS VEGAS, NEVADA 89128

**POGGEMEYER DESIGN GROUP – CITY OF NORTH LAS VEGAS**  
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**EXECUTIVE SUMMARY**

The Apex Industrial Park (AIP) has been widely acknowledged, by any number of economic experts within both public agencies and private consulting firms alike, as the potential driving force of considerable economic growth for Clark County, in general, but more directly for the City of North Las Vegas (CNLV). Some experts have stated that the future growth of commercial and industrial business within the AIP, in terms of building construction and employment projections, will be a sorely needed “boon” for the local CNLV economy. The term “boon” is roughly quantified by some of the most optimistic of economists as \$85 billion injected into the local economies of CNLV and other communities throughout Clark County over the next 20 plus years.

Most of the optimism for the expected commercial and industrial business growth is based on the recent commitment as made by Faraday Future to construct a \$1.4 billion initial phase of, what’s purported to be, a much larger manufacturing and assembly plant for electric automobiles at the AIP. Faraday Future’s commitment appears to be moving forward with the construction of the initial phase of their automotive manufacturing and assembly plant on an accelerated schedule. Some reports have stated that Faraday Future will have the indicated initial phase of the manufacturing and assembly plant completed and operational by the end of FY 2017. Faraday Future has also projected that their initial plant startup will employ an estimated 4,500 employees with high paying professional caliber jobs.

The positive projections for significant commercial and industrial business growth at the AIP appears to be credible and will have a major economic impact on CNLV’s tax base and related community growth for many years into the foreseeable future. With that said, the accelerated schedule for the construction and initial operation of the Faraday Future automotive manufacturing and assembly plant has placed considerable motivation on the CNLV to have in-place an adequate sanitary sewer collection system and wastewater treatment plant just before the new automotive manufacturing and assembly plant goes fully operational.

Accordingly, the Pre-Design report will present two options to plan, design and construct a new wastewater treatment plant within the existing AIP sanitary sewer utility service area. The new treatment plant will provide full secondary treatment to wastewater flows from the proposed AIP sanitary sewer system as projected over a 20 to 25 year planning period. The plant will be designed to meet and exceed all water quality regulations as administered by the Nevada Division of Environmental Protection for effluent discharge to the local hydrologic drainage basin. Plant effluent will be discharged as surface water to an existing wash immediately adjacent to both of the proposed plant sites and/or infiltrated into the underlying groundwater system. The report will also discuss the disposal of treated secondary effluent by evaporation in addition to the effluent reuse options of: 1) the possibility of contracting with AIP businesses to utilize secondary effluent as plant cooling tower water, and 2) utilizing secondary effluent to irrigate landscaping within the developed areas of the AIP.

The entire AIP is reported to have an estimated 20,000 acres of both developable and non-developable land. The AIP includes both mountainous and mildly sloping hillside topography ranging from near vertical to less than 5% slope. The wastewater treatment plant and associated sanitary sewer collection system considered in this report will serve 2,773.9 acres of developable land within the Mountain View, Northern Flats, Apex Commercial Center North, Pinnacle, North Apex, Faraday Future Automotive Plant, and Northern Flats West sub-industrial park developments.

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There are two proposed sites currently under consideration for the eventual construction and operation of the Apex wastewater treatment plant. A final selection will be made based on land costs, land availability, and eventual plant accessibility to both US Highway 93 and Interstate Highway 15.

One of the sites under consideration is located on two industrial lots within the Northern Flats sub-industrial park development with the second site located on a single lot within the Apex Commercial Center North sub-industrial park development. Both sites border an existing wash within the BLM utility corridor land. Negotiations are currently underway with the land acquisition consulting firm of Land Development Associates of Las Vegas who represent both property owners.

Regardless of which property is selected as the wastewater treatment plant site, the extended general area is assumed to be underlain with hard pan caliche clay that is further expected to add considerable excavation costs to place major concrete structures significantly below existing ground elevations. Consequently, all of the major concrete structures (headworks, bioreactor, clarifiers, disinfection channel, and post aeration basin) will all have to be constructed on shallow footings with the bulk of each structure placed above existing ground elevations.

In further consideration that the AIP sanitary sewer will have a piped outlet to the new wastewater treatment plant an estimated 15.0 ft. below existing ground elevation, a lift station will have to be constructed within the plant's headworks building to pump plant influent to an elevation allowing for gravity flow through all downstream process/treatment liquid train structures.

The various commercial and industrial businesses that typically construct and operate building or plants within major industrial parks are difficult to characterize in terms of both water use and sanitary sewer discharge contaminant loadings. Preliminary research of pertinent reference literature and consultations with the Nevada Division of Environmental Protection (NDEP) has provided some clarification in regard to criteria, guidelines, and standards that can be utilized to determine reasonable estimates for water use and expectations for sanitary sewer effluent contaminant loadings within an entire industrial park development.

As a result of the noted research and consultations, the Apex wastewater treatment plant will be designed for an average day flow of 1.20 mgd at buildout for the 2,773.9 acres of developable property within the proposed sanitary sewer collection system's service area as discussed previously. Phase I of the WWTP will be a 600,000 GPD plant. The peak day flow has been established at 2.4 mgd by applying a peaking factor of 2.0 to the stated average day flow rate.

The Apex wastewater treatment plant's influent contaminant loading is expected to be equivalent to loadings typically experienced with domestic residential developments. However, commercial or industrial operations that store or utilize toxic chemicals as part of normal plant operations will be required to actively and effectively implement pretreatment programs to preclude toxic chemical discharges to the AIP sanitary sewer collection system.

Treatment plant influent contaminant levels are expected to be 200 mg/l of BOD<sub>5</sub>, 210 mg/l TSS, and 10 mg/l of TKN with treated effluent contaminant levels expected to be 30 mg/l of BOD<sub>5</sub>, 30 mg/l of TSS, and 10 mg/l of TKN. The stated treated effluent contaminant levels are expected to be in full compliance

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with discharge standards as normally required for domestic secondary effluent within a National Pollutant Discharge Elimination System (NPDES) permit. An NPDES permit for the Apex wastewater treatment plant will be issued and administered by the NDEP.

The predesign report evaluates two basic activated sludge wastewater treatment plant configurations, or process options, that have been developed for treatment plants with relatively modest influent flow rates and typical contaminant loadings as generated from residential and light commercial service areas. An oxidation ditch in addition to a sequencing batch reactor process option has been evaluated for the Apex wastewater treatment plant application. Both process options have been proven to be more than capable of meeting and exceeding the above mentioned NPDES discharge requirements for the expected influent contaminant loading concentrations.

It needs to be stated that the proposed Apex wastewater treatment plant is recommended to be constructed in two separate phases as the AIP approaches full build out over an anticipated 20 to 25 year planning period. The two phased approach to the plant's construction will allow the CNLV to make structural and operational changes to the plant's final design should the AIP buildout projections prove to be inaccurate (either an over or under estimate) during the initial few years of ongoing plant operations.

The overall scheduling to complete the planning, design, construction, and plant startup requirements for the Apex wastewater treatment plant is a very significant issue that needs to be addressed as soon as the CNLV makes a decision to move forward with the plants design and construction work. It is of paramount importance that the project gets completed with the treatment plant being fully operational immediately prior to the projected date of completion for the first phase of the Faraday Future automotive manufacturing and assembly plant.

The evaluations of design and construction requirements for both plant process options clearly substantiates the need for CNLV to pursue an expedited project completion schedule that allows for the initiation of substantial construction work during the ongoing design process. To optimize the coordination of concurrent project work efforts, it is recommended that CNLV employ the construction manager at risk (CMAR) method of overall project management, or project delivery, to assure that both the engineering and construction phases of the project are completed within established budgets and schedules.

The CMAR option of project and construction management has proven to be successful at implementing fast-track project policies and methods to significantly reduce typical design-bid-build project completion schedules in addition to substantially reducing contractor change orders and unnecessary risks associated with owner and contractor litigations. That said, the CMAR approach to project engineering and construction management may prove to be somewhat more costly due primarily to the added likelihood of having to reconstruct or redesign some elements of a given project due to initially unforeseen site conditions, equipment availability issues, changed regulatory approvals impacting project deadlines, etc. while engineering and construction work is concurrently ongoing.

The implementation of the CMAR method of project management is expected to reduce the engineering and construction time schedule requirement from 33 months using the traditional design-bid-build method of project delivery to 18 months using CMAR project delivery or management practices.



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A recommendation to pursue the design and construction of either the oxidation ditch or sequencing batch reactor plant process options can only be based on an objective comparison of initial construction and annual operation and maintenance costs in addition to the ability of each process option to effectively treat the expected contaminant loads within sanitary sewer flows as generated from a large and diverse commercial and industrial park.

After a thorough and comprehensive evaluation of the process capabilities of both process options, it is found that either an oxidation ditch or sequencing batch reactor would more than adequate to effectively treat the expected hydraulic and contaminant loading from the AIP. The construction and annual operational costs for both process options are very comparable and within a plus or minus 10% contingency factor. However, since the sequencing batch reactor plant option appears to be more cost effective than the oxidation ditch plant option. We recommend the sequencing batch reactor plant as the selected alternative. Construction costs have been estimated at \$10.4 million and \$10.1 million for an oxidations ditch versus a sequencing batch reactor plant respectively. Annual operational costs have been estimated at \$278,000 and \$260,000 for an oxidation versus a sequencing batch reactor plant respectively.

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The Apex Industrial Park (AIP) is the largest industrial park in Nevada with a total park area of nearly 20,000 acres.

At total buildout over a 30 year planning period, the AIP is expected to attract numerous commercial and industrial businesses that are expected to construct nearly 40.0 million ft<sup>2</sup> of covered floor space for a broad range of business ventures or operations. These ventures or operations will typically be associated with retail and wholesale warehousing, manufacturing plants, mechanical assembly plants, product development and storage plants, materials testing laboratories, national and international corporate offices, etc. The commercial and industrial businesses that are projected to move all or a portion of their operations to the AIP are further expected to create tens-of-thousands of jobs over the stated 30 year planning period in CNLV and north Clark County.

Of primary note, or importance, is the pending construction of the Faraday Future car manufacturing and assembly plant within the existing Mountain View Sub-Industrial Park. Faraday Future has stated that the company will commit an estimated \$1.4 billion to construct the first of several phases of their state-of-the-art car manufacturing and assembly plant. The initial phase of the plant will allow for over 3.0 million in covered floor space and is projected to create 4,500 jobs by the planning year of 2017.

The stated aggressive schedule to bring the Faraday Future car manufacturing and assembly plant into initial production has dictated an equally aggressive schedule to plan, design and construct a new wastewater treatment plant to service the new Faraday Future plant.

As shown on Figures 1 and 2, "Vicinity Map and Project Site Map" and "Sanitary Sewer Service Area" respectively, the AIP is located in northern Clark County immediately West of Interstate 15 and South of US Highway 93.

There are two proposed sites for the Apex wastewater treatment plant (AWWTP). Site 1 is located within the Apex Northern Flats sub-industrial park with Site 2 located within the Apex Commercial Center North (ACCN) sub-industrial park. Two proposed sites are under consideration due to the ongoing negotiations to purchase the most reasonably priced, accessible and strategically located site for the construction and eventual operation of a wastewater treatment facility.

## **1.1 GENERAL AND PROJECTED INDUSTRIAL GROWTH IN NORTH LAS VEGAS AND CLARK COUNTY**

The City of North Las Vegas (CNLV) is currently experiencing a relatively healthy and sustained rate of growth in the residential, commercial, and industrial sectors of its local economy. The overall population growth rate for Clark County and the CNLV is between 1.5% and 1.9%. The price of new homes has risen 36.6% from sales data taken during 2015 with the average price of a residential home at or near the pre-



economic depression value of \$300,000. The Clark County unemployment rate is currently under 6% for the first time since 2008.

Given that the general and current economic numbers look favorable for sustained growth in the near term, long term economic growth is expected to be sustained through the construction and operation of the new Faraday Future automotive manufacturing and assembly plant within the AIP. The initial construction and operation of the Faraday Future plant is further expected to attract additional major commercial and industrial businesses to the AIP.

## **1.2 FARADAY FUTURE AUTOMOTIVE MANUFACTURING AND ASSEMBLY PLANT**

The state of Nevada Legislature passed four separate assembly bills during its December 2015 Special Legislative Session that were signed into law by Nevada Governor Brian Sandoval. These bills provided tax abatements and credits for the development of the proposed Faraday Future electrical vehicle manufacturing and assembly facility to be constructed at the AIP. Additional provisions of the legislation included money being set aside for the construction of utility improvements within AIP's developed sub-industrial park developments including drinking water, sanitary sewer, rail port, upgrading of Garnet Interchange, and a wastewater treatment plant.

Water service will be provided to the AIP by the Las Vegas Valley Water District and the Southern Nevada Water Authority. The upgraded water system will include two new water supply wells with two (2) 2.0 MG water storage tanks and distribution system requirements.

## **1.3 GENERAL ECONOMIC IMPACTS**

An exhaustive evaluation or assessment of the direct and indirect economic impacts that the Faraday Future automotive plant will have on the Clark County and the CNLV economies is beyond the intended scope of this report. However, it is not unreasonable to expect very significant economic impacts within the extended CNLV business community when hundreds-of-millions of dollars are steadily spent on local goods and services on a long-term and annual basis. The projected payroll of 4,500 Faraday Future employees alone will account for an estimated \$330.0 million per year spent on housing, living expenses, household goods, transportation, etc. The injection of significant money into the local economy should also allow for increased annual tax revenues that can generally be associated with assessed property values, retail sales, miscellaneous business developments, utility user fees, etc. Additionally, it is expected that the assumed increase in tax revenues will have a direct impact on the quality of life of existing and new residents within any number of local communities and related construction of significant community improvement projects, humanitarian programs, or community amenities.

## **1.4 COMMUNITY AND REGIONAL STAKEHOLDERS**



The planning, design, and construction of a new wastewater treatment plant to service commercial and industrial businesses at the AIP will affect the ongoing operations and financial business fortunes of a number of stakeholders such as commercial and industrial businesses owners, vendors and suppliers to said businesses, utility agencies, state and federal regulatory agencies, numerous businesses and their employees that provide indirect goods and services to AIP businesses, etc.

However, the most notable stakeholder is the CNLV which is charged with the direct responsibility to design and construct a new wastewater treatment plant within a very challenging time period. It is more than apparent to all the aforementioned stakeholders that the ultimate operation of the new Apex wastewater treatment plant (AWWTP) is a significant part of being in a position to construct new business buildings and/or industrial plants at the very earliest point in time. The overall development of the AIP is a highly visible undertaking with established and demanding schedules for the completion of basic utility services.

A couple of significant water and wastewater master plans that have been completed for the AIP.

The “Water and Wastewater Master Plan for the Apex Industrial Park” was completed in December of 2012. The master plan covered a service area of 7,523 developable acres out of a total acreage of 11,478 acres within the surveyed boundary of the industrial park including the entire service area of the proposed AWWTP. The master planned wastewater system included a proposed sanitary sewer collection system and temporary wastewater treatment plant to service the northern portion of the AIP.

The temporary treatment plant was subsequently recommended for decommissioning and replacement with three lift stations and accompanying force mains in order to convey AIP sanitary sewer to the existing CNLV wastewater treatment plant located near Nellis Air Force Base at Carey Avenue and Betty Lane. The master planned wastewater collection system was projected to service other industrial park developments including the Mountain View, Northern Flats, Pinnacle/Northern Apex, Northern Flats West, and ACCN sub-industrial parks as located within the overall AIP extended boundary. The wastewater collection system was planned to be extended to the first of the three lift stations generally located at the southwest corner of the intersection of US Highway 93 and Interstate Freeway I-15 for conveyance of wastewater to the existing CNLV collection system.

The “Apex Commercial Center North-Northern Flats Water and Wastewater Master Plan” was completed in March of 2014. The master plan addressed a number of issues to provide sanitary sewer collection service to the Apex Commercial Center North and Northern Flats sub-industrial parks for disposal at a proposed septic tank and leach field system. The master plan called for the eventual design and construction of a wastewater treatment plant in the event sanitary sewer flows within the studied service area exceeded 50,000 gallons per day.

The above referenced two previous wastewater master plans now provide the basis and criteria by which the sanitary sewer collection system and treatment plant will be designed and constructed to service the AIP as evaluated and discussed in this report. However, there are modifications to both master plans that need to be made to facilitate the proposed construction and operation of the Faraday Future automotive manufacturing and assembly plant.



As shown on Figure 2, the proposed AWWTP will be located in one of two locations with relatively direct access from US Highway 93 into either the Northern Flats or Apex Commercial Center North sub-industrial parks. Both proposed locations are located immediately adjacent to an existing wash within the BLM utility corridor running northeasterly through the eastern-most limits of the AIP and bisecting both of the stated sub-industrial parks.

### **3.1 SITE LOCATION**

Two potential site locations are given for the proposed AWWTP primarily due to ongoing negotiations to secure ownership of either site. Site 1 is located within the existing Northern Flats sub-industrial park and has 30.8 acres of land to construct and operate the proposed AWWTP. Site 2 is located within the existing ACCN sub-park and has 12.05 acres of potential plant construction and operations area. Both sites slope toward the existing wash area but their average ground elevations differ by roughly 10.0 ft., with the average elevations of both sites at 2,180 ft. to 2,190 ft. above MSL for Site 1 and Site 2 respectively.

The proposed layouts for two AWWTP options (oxidation ditch and sequencing batch reactor) on Site 1 and Site 2 are as shown on Figures 5 through 8.

### **3.2 EXISTING UTILITY SERVICES**

Either of the proposed AWWTP site locations is completely situated on undeveloped lands with no existing utilities. Electrical power will have to be provided from existing and/or new substations owned and operated by NV Energy. The substation also provides electrical power service to the nearby Love's Travel Stop located at the intersection of Interstate Freeway I-15 and US Highway 93.

### **3.3 CLIMATE AND WEATHER**

The two site options for the proposed AWWTP are both located within a typical southern Nevada high desert area. The climate can be characterized as having hot-dry summers subject to occasional thunderstorms and mild winters with sparse-intermittent precipitation events. The annual average precipitation is approximately 4.3 inches with an average of about 22 days of precipitation per year. The annual average temperature is 69 °F and for the month of July with an average high of 104 °F and average low of 78 °F. The average high in the month of December is 58 °F with the average low at 37 °F. The general area only averages 12 days per year below freezing with the lowest temperature on record at roughly -15 °F as recorded in 1947.

It needs to be noted that the hot and dry climate at the AIP is, for the most part, is conducive to the operation of a wastewater treatment plant in regard to a near complete lack of sustained freezing weather and the potential for reducing plant effluent discharge to the existing wash bordering both of





the proposed AWWT sites through the evaporation of plant effluent within an infiltration and evaporation pond.

Record pan evaporation data as taken from several National Oceanic and Atmospheric Agency (NOAA) weather stations in both Las Vegas and Boulder indicate an average annual evaporation potential for the extended region of between 115 inches per year to 120 inches per year. That equates to an average of 9.60 acre-ft. to 10.0 acre-ft. per acre per year of direct effluent evaporation. Without taking into consideration marginal soil infiltration losses due to assumed hard pan caliche lenses within the underlying soil profile, a 1.20 mgd average day flow plan, at the proposed AWWTP, would roughly require a 135.0 acre evaporation pond for a zero effluent discharge treatment facility.

The proposed AWWTP sites are only 30.8 acres and 12.1 acres in size for Site 1 and Site 2 respectively. Consequently, additional acreage for an off-site evaporation pond will have to be acquired.

### **3.4 VEGETATION, TOPOGRAPHY, AND APEX SANITARY SEWER SERVICE AREA**

The site and surrounding area of the proposed AWWTP generally supports vegetation requiring very little water to survive in the hot-dry local climate. The dominant vegetation includes various species of sage and creosote bush in addition to various species of cacti. Other vegetation or plant growth is generally sparse and typically limited to Joshua and other species of coniferous trees.

The topography within the overall AIP varies from steep mountainous terrain to relatively mild sloping acreages that are readily developable into building pads for commercial and industrial business buildings or plants. The elevation within the AIP varies from roughly 2,920 ft. to 2,150 ft. above MSL. The 770.0 ft. of elevation differential is mostly accounted for by AIP's steep mountainous areas at its western and southerly most boundary as compared with its low-lying mildly sloped areas near US Highway 93 and Interstate Highway I15. It has been estimated that 25% to 30% of the total area within the AIP is undevelopable due to steep slopes (30% plus) within the aforementioned mountainous areas.

As mentioned previously in this report, the AIP accounts for nearly 11,000 acres of total area within its platted boundary. Of that, only 2,774 acres are within the AWWTP sanitary sewer service area as shown on Figure 2.

### **3.5 SOILS AND GENERAL SUBSURFACE CONDITIONS**

The soils within the AIP service area and proposed AWWTP plant site options are typical of most Southern Nevada's high desert plains. Soils in these areas generally include well-drained silty sand and gravel materials lying over solidified limestone formations. These solidified or cemented sediments are commonly referred to as "caliche" and have been confirmed as a major component of the soil profile within the extended area encompassing both of the proposed AWWTP sites. The confirmation of caliche



within the local soil profile was made from a review of a recent geotechnical report to construct an RV park adjacent to the existing Love's Truck Stop or Travel Center at junction of US Highway 93 and Interstate 15. Five boreholes were drilled within less than a quarter mile of the proposed AWWTP site options that clearly confirm the existence of hard-pan caliche within a few inches (12 inches to 48 inches) of existing ground elevation. The caliche layer extends to a depth of well over 15 ft.

Due to the expectation of finding a comparable layer of hard-pan caliche clay, at either of the proposed WWTP construction sites, it can be realistically expected that the various concrete structures associated with the new wastewater treatment plant will have to be constructed on shallow footings with most of a given structure's basin and vertical walls extending above existing ground elevations. Any attempt at major excavation work, to lower various plant structures, is considered too cost prohibitive and has not been considered with the various evaluations presented in the remainder of this report.

### **3.6 HYDROLOGY AND STORM RUNOFF PROJECTIONS**

Both of the proposed AWWTP sites are generally located directly upstream of a proposed surface runoff detention basin and downstream of a proposed improved surface runoff channel. Both the detention basin and channel are to be constructed and eventually operated by the Clark County Regional Flood Control District. Both the detention basin and surface runoff channel are acknowledged as having only a marginal association, or impact, on either of the projected AWWTP sites. The conveyance and detention of design-year flood flows utilizing the detention basin or channel will not affect the eventual construction or operation of the AWWTP in anyway.

Both of the proposed AWWTP sites are located within what is known as the Garnet Valley of Clark County, Nevada hydrologic sub-basin of the much larger multi-state Colorado River Basin. As mentioned previously, the local climate is exceedingly hot and dry with an average annual precipitation amount of 4.3 inches. Accordingly, any significant storm runoff within the wash immediately adjacent to either of the proposed AWWTP sites will be the result of cloudbursts from localized thunderstorms. A comprehensive precipitation and storm runoff evaluation will be completed to confirm the findings of the Clark County Regional Flood Control District that expected design year flood flows within the existing wash will not encroach on to the AWWTP site.

As shown on Figure 2, the overall AIP includes a number of existing sub-industrial park developments in various phases of development including the construction of access streets, sanitary sewer systems utilizing septic tanks and leach fields, in addition to drinking water distribution systems fed from local wells. That said, the expected construction of the Faraday Future automotive manufacturing and assembly plant has obviously changed the immediate needs for water-related utility systems and facilities within all the indicated sub-industrial park developments. And with the planned construction of both water and wastewater utility systems and facilities, land use within the overall AIP may become somewhat more diversified in terms of the type of commercial and industrial business operations expected to purchase building pads within a given sub-industrial park development.

#### **4.1 CURRENT CITY OF NORTH LAS VEGAS (CNLV) ZONING**

The entire area encompassing the northern portions of CNLV's incorporated boundary, including the AIP, is currently zoned M-2 Heavy Industrial. The M-2 zoning designation is consistent with the planning, construction, and operation of commercial and industrial businesses involved with a very comprehensive range of business enterprise from support administrative services to heavy manufacturing. The overall M-2 zoning is expected to remain in place for the foreseeable future given the expected scope and nature of operations at the new Faraday Future automotive plant. However, slight changes to the zoning ordinance might be warranted to establish areas within the overall AIP that might be deemed favorable to businesses that might prefer some level of isolation from heavy industrial manufacturing or fabrication plants that generate excessive noise and store toxic chemicals.

#### **4.2 EXISTING BUSINESSES AND LAND OWNERSHIP**

A listing of existing private businesses and landowners in and around the AIP and extended AIP area is provided as follows:

1. Love's Travel Stop and RV Park - A truck stop with a convenience store, fast food restaurants and a recreation vehicle park.
2. UNEV Las Vegas Terminal - The terminal facility for a pipeline conveying petroleum products from Utah to Nevada. The facility includes storage tanks and truck filling stations for distribution throughout southern Nevada.
3. Apex Solar Facility - A 154 acre, 20 megawatt solar power generation facility operated by the Southern Company Turner Renewable Energy.
4. Mountain View Solar – A 146 acre, 20 megawatt solar power generation facility operated by Mountain View Solar, LLC.
5. Silverhawk Generating Station and Silverhawk Plant North Las Vegas - A 520 megawatt natural gas fired power generation facility owned and operated by SNWA.
6. A private medical marijuana farm at the Old Kerr McGee Fireworks Storage Industrial Site.

7. Chuck Lenzie Generating Station - A 1,102 megawatt, natural gas fired power generation station owned and operated by NV Energy.
8. Lhoist North America Apex Plant – A sand and gravel mining operation.
9. Georgia Pacific Gypsum Division Las Vegas Plant – A gypsum mining operation.
10. Harry Allen Generating Station – A 628 megawatt natural gas fired power generation facility.
11. Apex Generation Plant – A 600 megawatt generation station owned and operated by Southern California Public Power.

It needs to be noted that all the listed businesses are involved with moderate to heavy industrial plant operations, fueling stations for mostly highway semi-trucks and trailers, electrical power generation, mineral mining operations, rock products suppliers, and farming operations to grow medical grade marijuana. All these businesses generate noise, heavy traffic, some level of odorous air emissions, etc. Consequently, the planned construction and operation of the AWWTP is not expected to register any opposition within the immediate area or within the local industrial business community.

In addition to the industrial businesses listed above, the US Bureau of Land Management owns and operates thousands of acres in-and-around the AIP. Of primary concern, or importance, is the use and administration of the existing utility corridors that are expected to accommodate the construction and operation of all buried utilities that will eventually service the entire AIP. These utilities will obviously include all drinking water trunk lines and distribution lines that are now being proposed by both the Southern Nevada Water Authority and Las Vegas Valley Water District. The construction of sanitary sewer force-mains or gravity lines is not expected to be significant issues due to the planned construction of the AWWTP. However, the discharge of AWWTP effluent to the existing wash within the BLM utility corridor may require the submittal of various applications to secure federal approval to discharge secondary wastewater effluent into an existing non-perennial stream channel. This issue will be researched and/or investigated through the Nevada Division of Environmental Protection (NDEQ).

The remaining major AIP industrial business and landowner is obviously Faraday Future. As previously discussed, Faraday Future's automotive manufacturing and assembly plant will be the first significant business venture to locate at AIP with the construction of a 3.0 million ft<sup>2</sup> plant on a 900+ acre industrial site in Mountain View Industrial Park.

### **4.3 COMMERCIAL AND INDUSTRIAL BUSINESS PROJECTIONS**

CNLV in partnership with the private land development consulting firm Land Development Associates is aggressively promoting industrial and commercial business development at the AIP. The goal of the ongoing promotional campaign is to take advantage of the recent decision by Faraday Future to locate its state-of-the-art automotive manufacturing and assembly plant at the AIP with additional consideration given to the improving regional and national economy.



As mentioned previously in this report, the potential influx of commercial and industrial business interests to the AIP would result in a projected infusion of hundreds-of-millions of dollars into the general North Clark County economy. CNLV is expected to be the biggest beneficiary of the planned upswing in commercial and industrial business growth through significantly improved levels of tax revenues and revenues to local-community businesses.

CNLV's promotional efforts are targeting commercial and industrial businesses involved with a wide variety of business operations, or ventures, that are typically associated with commercial truck refueling and maintenance, warehousing and distribution, light to heavy industrial fabrication and manufacturing, electrical power production and distribution, in addition to the development of renewable solar and biodiesel energy sources.

The AIP is being promoted as a very business friendly and construction ready industrial park as attested to by the approval and active administration of the new Apex Overlay District (AOD) by the CNLV. The AOD was developed and specifically laid out to simplify bureaucratic regulations to generally expedite the eventual construction of new commercial and industrial buildings within the extended AIP sub-industrial park developments.

Additionally, some of the strongest selling points to attract commercial and industrial businesses to AIP include the relatively inexpensive price of improved building pads, suspension or waiver of business income taxes to new businesses ventures, establishment of a foreign trade zone, in addition to AIP's overall accessibility to McCarran International Airport and major west coast business hubs that include Los Angeles, Salt Lake City, Phoenix, San Francisco, and Denver.

As of the date of this report, there have been no significant and/or formal projections regarding the number or timing of businesses constructing new buildings or plants at the AIP. The expectation is that all of the fully improved building pads will be successfully sold within a reasonable 20 to 30 year planning period given sustained growth projections for both the regional and national economies. The stated expectation has been adopted from the current upswing in the overall Clark County economy in addition to record commercial and industrial business growth within the Reno-Tahoe Industrial Center (TRI) in Northern Nevada.



Water demand for industrial businesses is difficult to forecast primarily due to the extreme differences with water use by any given type or category of business operation. Some commercial and industrial business operations use excessive volumes of water while others have insignificant water demands.

Sanitary sewer flows are typically directly tied to indoor drinking water demand or use. Residential sanitary sewer flows are estimated from applying a gallons per capita number to the average population per household (sewer connection) with allowances for conveyance losses. Sanitary sewer flows for commercial retail sales or business office operations are typically tied to the square-footage of floor area, number of toilets, number of employees, etc. Sanitary sewer flows for industrial businesses have to be evaluated on a case-by-case or business-by-business basis which is not practical for the AIP service area.

Consequently, sanitary sewer flows for the AIP service area was calculated by applying the factor of 0.50 acre-ft. per acre-year to the net developable acreage within the AIP for average annual sanitary sewer flows to the proposed AWWTP. As summarized in Appendix A, the average day wastewater plant influent flow for the expected AIP buildout service area of 2,773.9 acres is 1.20 mgd. The peak day flow for the AWWTP is further calculated at 2.40 mgd by applying a 2.0 peaking factor to the average day flow of 1.20 mgd. AIP is often compared with the Tahoe Reno Industrial Center (TRI Center) with a total park area of over 100,000 acres.

The construction of the AWWTP is recommended to be completed in two separate phases depending on projections of future building, or plant, construction within the overall AIP. Accordingly, the values of average day flow at 0.60 mgd and peak day flow at 1.0 mgd will be used to design each of the two phases of the AWWTP.

It needs to be noted that average day flow rates are one of the primary considerations for the biological or biochemical process design for a given wastewater treatment plant. Peak day flows are typically used to design and size flow measurement structures and primary treatment systems or equipment including bar screens and grit removal chambers. Peak day flows are also used to design a given plant's disinfection channel that involves the injection of chlorine into plant effluent as it flows through a serpentine discharge channel or the passing of plant effluent between ultraviolet light panels within a narrow discharge flume.



Wastewater quality, as assessed for treatment and eventual discharge into a receiving stream or to be reused in some alternate manner, is typically characterized by concentrations of various regulated contaminants; the most basic of which include five day biological oxygen demand (BOD<sub>5</sub>), total suspended solids (TSS), and total kjeldahl nitrogen (TKN). All three of the contaminants are typically evaluated in terms of milligrams per liter (mg/l) of contaminant.

As is the case for predicting sanitary sewer flows, any effort to characterize wastewater plant influent water quality is equally as difficult. Basic research of the literature (Water Environment Federation Journals and NDEQ Administrative Code and Regulations) in addition to a number of phone consultations with NDEQ staff has substantiated that it can be reasonably expected to see contaminant loadings at the proposed AWWTP that are comparable to typical domestic residential contaminant loadings. A summary of both expected plant influent contaminant loadings and total maximum daily limit (TMDL) values for regulated plant effluent contaminant loadings are given in Table 1.

It needs to be noted that the projected water quality values given in Table 1 for both plant influent and effluent flows are comparable to actual water quality data that has been recorded at the existing SBR wastewater treatment plant at the Reno-Tahoe Industrial Center.

The proposed AWWTP will have to meet the TMDL contaminant levels, as given in the Table, to secure a National Pollutant Discharge Elimination System (NPDES) permit from the NDEP for possible effluent discharge to the existing wash immediately adjacent to both optional plant sites.

**TABLE 1**  
**EXPECTED AWWTP INFLUENT AND EFFLUENT CONTAMINANT LOADINGS**

Regulated Contaminant	Expected Influent Loading	Regulated Effluent Loading
BODs	200 mg/l	30 mg/l
TSS	210 mg/l	30 mg/l
TKN	40 mg/l	10 mg/l

It needs to be noted that additional tertiary treatment may be required depending on the assumed or stated water quality of the receiving stream or water quality that may be required for any proposed effluent reuse option. Tertiary treatment is associated with the removal of excessive nitrogen and/or phosphorus within the plant's effluent flow. Discharge into the aforementioned wash is not expected to require nutrient removal. However, effluent infiltration into the local groundwater aquifer may require nutrient removal after the possible mandatory monitoring of groundwater quality for a specified period of time by the NDEP.

As alluded to above, neither sanitary sewer flows nor contaminant loadings can be accurately projected from industrial business operations; especially contaminant levels for operations that require the storage and regular use of various toxic and regulated chemicals. Discharges from these types of



operations have to be diligently monitored to assure that toxic chemicals, that would significantly upset the biological processes within the proposed AWWTP, do not get mixed-in with sanitary sewer discharges from buildings or plants that support these types of operations.

Plant operations that need to store and utilize toxic chemicals will have to implement a pretreatment program to effectively mitigate any and all reasonable possibilities of contamination to AIP's sanitary sewer collection system. The implementation process will most likely include the submittal of a pretreatment plan for review and approval by both the CNLV and the NDEP. NDEP has published a list of priority pollutants (reference Appendix B) that require removal from the sanitary sewer discharge stream via an approved industrial pretreatment program.





Some of the existing, and privately owned, sub-industrial park developments within the proposed AWWTP sanitary sewer collection service area are currently utilizing a collection of septic tank and leach field systems to sewer existing commercial and industrial buildings or plants. The locations and extent of these septic tank and leach field systems are not accurately known as of the date of this report. It is expected, however, that these systems will be abandoned as soon as the new AWWTP collection system is constructed and operational.

As shown on Figure 2, the proposed sanitary sewer collection system will effectively provide sewer hookups to building pads within the sub-industrial park developments of Northern Apex, Pinnacle, Kapex, Northern Flats, and Northern Flats West. The Apex Commercial Center North sub-industrial park development may be serviced by the AWWTP but, in all likelihood, the landowner or developer would have to install a lift station and force-main to discharge the development's raw sewerage into the proposed AWWTP.

The overall boundary of the sanitary sewer service area encompasses both steep and relatively mild sloping topography. The excessively steep areas are considered undevelopable and were not considered in the AWWTP average day flow calculations using the 0.50 acre-ft. per acre-year sanitary sewer flow factor. The sanitary sewer alignments shown on Figure 2 are primarily located within sub-industrial park developments with mild sloping topography. The entire sanitary sewer has been laid out to be a gravity flow system that generally flows in a northeasterly direction to its point of discharge at either of the two proposed AWWTP plant sites.

Pipe sizes for the proposed collection system range from 8 inches to 24 inches in diameter. A summary of pipe sizes and lineal pipe footage is provided in Table 2.

**TABLE 2**  
**SANITARY SEWER PIPE DIAMETERS AND LINEAL FOOTAGE**

Pipe Diameter (inches)	Length (feet)
8	6,036
10	4,202
12	22,249
15	17,675
24	11,429
<b>Total Lineal Footage</b>	<b>61,591</b>

This report has evaluated the overall cost effectiveness in addition to the operational advantages and disadvantages that can be associated with a proposed wastewater treatment plant to service the AIP. The evaluations presented in this report has considered a number of factors that have included, but certainly not limited to, site location, expected magnitude of wastewater influent flows, expected influent contaminant loadings, overall plant durability and reliability, effluent water quality regulations, and effluent reuse options.

The following sections of this report provide discussions associated with the projected operation of various components of a complete wastewater treatment facility providing primary, secondary, and partial tertiary treatment to typical domestic wastewater streams. The following sections of the report will also assess the feasibilities, costs, operational advantages, and disadvantages of two basic treatment plant configurations utilizing an oxidation ditch versus a sequencing batch reactor (SBR) processes.

Schematic drawings of both types of secondary treatment plants are as shown on Figures 3 and 4 for an oxidation ditch plant and SBR plant respectively.

## **8.1 PRIMARY TREATMENT**

Primary treatment is the treatment that wastewater influent receives immediately upon entering a wastewater treatment plant after being discharged from a wastewater collection system or sanitary sewer. The proposed Apex wastewater treatment plant (AWWTP) will include a headworks building that will house influent lift pumps, influent screen, and grit removal system.

As stated previously, the total plant buildout capacity is estimated at 1.2 mgd for average day wastewater influent flow and 2.4 mgd for peak day wet weather flow. It's anticipated that the AWWTP will be constructed in two separate phases as development of the AIP moves from the single Faraday Future automotive manufacturing and assembly plant to full occupancy by other industrial and commercial businesses over an assumed 20 year planning period (2017 through 2037). As a result, the AWWTP will be designed to accommodate 0.6 mgd of average day flow and 1.2 mgd of peak day wet weather flow per phase. The various mechanical and hydraulic components of the AWWTP's primary treatment system will be selected and designed to accommodate 1.2 mgd for each of the two proposed phases of plant design and construction with the exception of specific situations where the economics of extended plant operations and phased construction costs dictate otherwise.

### **INFLUENT LIFT PUMPS AND FLOW METERING**

A preliminary evaluation of the existing topography of the AIP and proposed AWWTP site indicates that a sanitary sewer servicing the AIP will outlet to the AWWTP at an estimated elevation 15.0 ft. below existing ground elevation at the plant's headworks. As a result, the operation of the AWWTP will

require an influent pumping station to lift sanitary sewer flows to an elevation allowing for the headworks influent channel to be constructed well above finished site grade.

The headworks influent channel includes the plant's mechanical trash screen and grit removal system. The decision to elevate the influent channel will preclude the necessity of extensive and costly excavation to construct the plant's bioreactor, secondary clarifiers (oxidation ditch option only), UV channel, and post aeration basin below an assumed hard pan layer of caliche clay material either of the proposed plant sites.

The influent pump system for Phase 1 will consist of three (3) pumps with variable speed drives each capable of pumping a peak flow rate of 0.8 mgd. With one pump out of service, the pump system will still be capable of pumping the Phase 1 peak hydraulic flow rate of 1.2 mgd. A space will be provided for a future fourth pump capable of pumping 0.8 mgd. This fourth pump will be added as part of the AWWTP's full buildout phase with a peak hydraulic pumping capacity to 2.4 mgd via three (3) pumps.

Influent flow will be metered by use of a single mag meter installed at the discharge piping manifold for all three submersible lift pumps.

Hydraulic profiles for both the oxidation ditch and SBR bioreactor plant options are as shown on Figures 9 and 10 respectively. The profiles provide a rough graphical representation of the relative elevations of all process structures, equipment and systems in comparison to proposed plant site finished grade elevations.

### **MECHANICAL INFLUENT SCREEN**

Relatively large and stringy debris is removed from plant influent flow streams by passing through a stationary screen with all collected trash and debris removed utilizing an automated mechanical cleaning arm that is typically an integrated part of the overall screen design. Additionally, screen trash and debris is typically deposited into a hopper of a mechanical screw auger that, in turn, deposits collected influent trash and debris into a metal trash bin to eventually be hauled from the plant headworks building to a local landfill. The overall operation of the mechanical screen and screw auger is typically done automatically by setting on and off cycles on a digital timer or wheel lever.

The mechanical influent screen shall be designed to pass the maximum plant buildout capacity of 2.4 mgd during Phase 1 construction. It has been determined that there is very little cost savings to justify the design and installation of two smaller screens for Phases 1 and 2.

**HYDRAULIC AND MECHANICAL GRIT REMOVAL CHAMBERS / SYSTEMS**

Grit is typically defined as granular solids suspended in domestic wastewater flows consisting of particles of sand, gravel, miscellaneous mineral matter, and putrescible organic substances such as coffee grounds, egg shells, fruit rinds, vegetable seeds, and the like. Most grit materials have relatively higher densities, or specific gravity values, than wastewater influent which allows for the somewhat rapid settlement of grit solids from wastewater flows upon entering a given treatment plant's headworks.

There are three basic grit removal processes that are incorporated into grit removal equipment and/or systems as manufactured by any number of private companies or vendors. These processes include aerated grit chambers, vortex grit chambers, and constant velocity grit channels. A vortex grit chamber is recommended for the AWWTP.

The vortex grit chamber will be selected and designed to pass the plant buildout capacity of X mgd due to the lack of any substantial cost savings for the design and installation of two smaller units for plant Phases 1 and 2.

**GREASE AND OIL TRAPS**

Grease and oil contamination of domestic wastewater is almost exclusively attributed to restaurants and residential homes within a given wastewater treatment plant's service area. Given the fact that the AIP is not expected to include restaurants or residential homes, it's doubtful that grease and oil contamination will be of any significant issue with influent flows to the proposed AWWTP. As a result of the expected low, to nonexistent, grease and oil contamination levels of plant influent flows, no specialized equipment or design modifications is planned or contemplated for the headworks facility for grease and oil removal. The City will require any future oil and grease discharges to install the necessary grease/oil separators as part of the pretreatment program.

**8.2 SECONDARY TREATMENT**

Secondary treatment is focused on the removal of both dissolved and suspended solids in the wastewater stream beyond primary treatment and the stabilization of wastewater sludge through the utilization of microbiological organisms. Secondary treatment also focuses on the removal of selected nutrients in the wastewater flow stream as required to meet plant effluent water quality requirements as administered by the Nevada Division of Environmental Protection (NDEP).

As mentioned above, secondary treatment at the proposed AWWTP will incorporate one of two basic plant bioreactor options: oxidation ditch or sequential batch reactor (SBR).

Liquid train secondary treatment requirements for an oxidation ditch plant versus an SBR plant incorporate significantly different process methods or schemes. As noted in Table 1, both treatment plant process options (oxidation ditch versus SBR) will be required to meet and exceed expected NPDES discharge requirements as administered by the NDEP.

However, the solids train treatment systems for both types of plants are essentially the same as shown on the process schematic drawings for both plant options (Figures 3 and 4 respectively). These differences and similarities in addition to an assessment of operational advantages, disadvantages, and comparative construction and operational costs are discussed in the following sections of this report.

### **DESIGN STANDARDS AND NDEP REGULATIONS**

The construction drawings and specifications for the AWWTP will be thoroughly reviewed by the NDEP as a requirement for certification of the plant's eventual operation and to acquire a National Pollutant Discharge Elimination System (NPDES) permit as eventually administered by both the NDEP in conjunction with the federal Environmental Protection Agency (EPA).

Accordingly, the preparation of the plant's construction documents will be required to adhere to design standards that are widely accepted within the wastewater treatment plant design and operations industry and as accepted by both the NDEP and EPA as acceptable practice for plant designers.

The Nevada Administrative Code (NAC 445A.284) specifically lists the following standards and manuals as acceptable practice to design the AWWTP:

- Ten States Standards, Recommended Standards for Wastewater Facilities, as published by the Wastewater Committee, Great Lakes and Provincial Public Health and Environmental Managers; 2014 Edition.
- WEF Manual of Practice No. 8-ASCE Manuals and Reports on Engineering Practice No. 76, Design of Municipal Wastewater Treatment Plants, as published by the Water Environment Federation, American Society of Engineers, and Environmental & Water Resources Institute; Fifth Edition, 2009.

In addition to the above cited design standards and manuals, the NDEP published a number of Water Technical Sheets that provides basic standards for a comprehensive list of plant design, water reuse, general water quality, pumping station, sludge/bio-solids handling, pretreatment, plant design and operations-related issues.

The final operation of the AWWTP will be required to meet and exceed all water quality standards as administered by the NDEP and as stated in NAC 445A.228 through NAC 445A.263 as said standards apply to traditional domestic wastewater flow streams.

**OXIDATION DITCH WITH FINAL CLARIFIERS**

The oxidation ditch option for Phase I consists of a two (2) channel looped reactor system with each concentric channel 14 feet in width and side water depth of 12 feet with a 600,000 GPD averages daily flow. Overall ditch dimensions are approximately 70 feet wide by 94 feet in length. Each independently aerated channel is paralleled or in series with the other channel to reduce the wastewater to tertiary treatment levels. Typical operating results include overall denitrification performance rate of 80% without internal recycle, biochemical oxygen demand reductions of 95% and higher, suspended solids removal under 10 mg/l and non-bulking mixed liquor. After screening and grit removal, influent enters the outer channel where most of the biological removal is accomplished. It is maintained at or near a zero dissolved oxygen level. Aeration disks are provided to aerate zones for the nitrogen (ammonia) removal producing nitrates. As the nitrates enter the zero dissolved oxygen environment, denitrification occurs. Mixed liquor from the outer channel flows to the inner channel where the mixed liquor is kept at 2 mg/l dissolved oxygen for polishing (final CBOD and ammonia reduction). During a rainfall/high peak flow event, the concentric oxidation ditch process can enter a stormwater treatment mode. The solids inventory (mixed liquor) or microorganisms are pumped to the outer channel to prevent solids washout while the stormwater/high peak flow is directed to the inner channel. When flow returns to normal, the influent wastewater is simply returned to the outer channel and treatment proceeds routinely.

The orbal oxidation process which is considered extended aeration does not require primary settling tanks. Two (2) final settling tanks, each 32 foot diameter x 12 foot side water depth will provide peak hydraulic treatment up to 1.2 mgd for suspended solids removal.

To accommodate the final build out Phase II average day flow rate of 1.2 mgd and peak flow rate of 2.4 mgd, a third outer ring will be added to the oxidation ditch along with two (2) additional final clarifiers. Essentially the third outer ring equals the volume of the two (2) rings provided under Phase I.

**SEQUENCING BATCH REACTOR**

The SBR process is a variant of the activated sludge process. A conventional SBR system uses the fill and draw principal in which unit processes (aeration, anoxic mix, and clarification) occur sequentially on a cyclical basis within a single tank. The SBR process therefore eliminates the need for primary and secondary clarifiers.

The SBR system evaluated for Phase I is a 600,000 GPD is an ICEAS process. This SBR process is a modification and enhancement of the conventional SBR. ICEAS, an acronym for Intermittent Cycle Extended Aeration System, allows continuous inflow of wastewater to each individual basin. Influent flow to the ICEAS SBR basin is not interrupted during the settle and decants phases or at any time during the operating cycle as in a conventional SBR system. Therefore, in a two (2) tank system as proposed for



Phase I, a single tank can be completely taken out of service for maintenance or low flow conditions without interrupting the treatment process. Another two (2) tank SBR system which can operate on a single tank for extended periods of time is the Aqua SBR as manufactured by Aqua Aerobics, Inc.

The typical ICEAS SBR process consists of the following time-based phases:

FILL/REACT	Raw wastewater that has been screened and degrittled flows into the basin and mixes with the mixed liquor. The basin is aerated while filling and biological oxidation takes place simultaneously.
SETTLE	Aeration is stopped and the solids settle to the bottom of the basin leaving clear water on top. The basin continuously receives influent flow.
DECANT	The clear water is discharged from the top of the basin via a decanter. Typically, sludge is wasted during this phase of the cycle. The basin continuously receives influent flow.

The SBR option for Phase I consists of two (2) tanks each 26 feet wide by 74 feet long with a maximum side water depth of 18 feet. Each tank is divided into two zones – a pre-react zone and a main react zone. A baffle wall with openings at the bottom separates the two zones. The volume of the pre-react zone is typically 10 to 15 percent of the total basin volume. To accommodate the additional flows associated with Phase II final buildout, two (2) additional SBR basins equal in size to those provided as part of Phase I would be added.

## TERTIARY TREATMENT

The tertiary filtration system for the Phase 1 Oxidation Ditch Option will consist of two (2) tanks housing vertically oriented cloth media filtration disks. Each unit will be capable of treating a peak hydraulic flow rate of 1.2 mgd thus providing one complete standby unit. A third unit capable of treating 1.2 mgd will be added as part of the Phase 2 final buildout which allows the treatment of 2.4 mgd with one unit completely out of service.

Due to the higher peak decant rate of 2.1 mgd associated with the SBR system, the filtration system for this option will consist of three (3) tanks each housing vertically-oriented cloth media filtration disks. Each unit will be capable of treating a peak hydraulic flowrate of 1.05 mgd thus providing one complete standby unit. Two (2) more units each capable of treating 1.05 mgd will be added as part of the Phase 2 final build out which allows for the treatment of 4.2 mgd with one unit completely out of service.

Following biological treatment, clarified effluent enters each tank completely submerging the stationary cloth media disks. By gravity, liquid passes through the cloth media to the hollow center collection tube where it is directed to final discharge. As solids accumulate on the surface of the cloth media, the water

level rises within the individual filtration units. Once a predetermined level is reached, the disks rotate and the cloth media surface is automatically cleaned. Filtration operation is not interrupted during this cycle. Heavier solids are allowed to settle to the bottom portion of each filter unit. These solids are then pumped on an intermittent basis back to the headworks area of the treatment facility.

## **DISINFECTION**

The removal of pathogenic organisms from wastewater treatment plant effluent is typically accomplished by either the chlorination of plant effluent or the passing of narrow streams of effluent through banks of ultraviolet (UV) light emission panels. The AWWTP will most likely be required to meet basic domestic sewage treatment standards for fecal coliforms. Both of the aforementioned treatment options will meet and exceed expected fecal coliform cfu or mpn per 100ml contaminant standards as will be dictated by the plant's NPDES permit and as administered by the NDEP (200 to 300 cfu per 100 ml).

Older wastewater treatment plants have historically utilized chlorination systems to kill pathogenic organisms through the injection of chlorine gas in plant effluent flows. Chlorination systems typically require the storage of chlorine gas/liquid in one-ton steel cylinders that discharge volatile chlorine gas into plant effluent flows through the use of proprietary injection systems. Once injected, excess chlorine gas is dissipated by diverting plant effluent into serpentine rectangular concrete outfall channels.

In recent years, owners and operators of municipal wastewater treatment plants have begun to opt for UV systems to disinfect wastewater plant effluent. The rationale is that UV disinfection systems are safer to use as compared with chlorination systems. Comparatively, the storage of chlorine cylinders and related transfer of chlorine gas to remote injection equipment poses a potential health risk to plant personnel, and the immediate surrounding area, in the event of a significant chlorine gas spill or leak. Accordingly, UV disinfection is recommended for the AWWTP application.

The UV disinfection system requires the construction of a concrete structure with two common wall influent flow channels. For the Oxidation Ditch Option, each channel will be designed to pass 1.2 mgd through two banks of UV panels attached to both walls of an individual channel. Only one channel will be put into service for Phase 1 of the plant's initial construction with the second channel being put into service during Phase 2.

Due to the higher decant rate with the SBR Option, the UV system associated with this option will be a two (2) channel system each capable of passing 2.1 mgd. Under Phase 1, UV panels will only be placed in one of the channels. Phase 2 will include the installation of UV panels in the second channel to accommodate the SBR peak decant rate of 4.2 mgd.



**POST AERATION**

AWWTP plant effluent will be aerated immediately prior to being discharged for reuse or as reclaimed water for any of the proposed reuse/reclaimed water application options discussed in this report. The purpose of the post aeration measure is to assure that levels of dissolved oxygen are optimized for the indicated and various reuse/reclaimed water applications.

**PLANT EFFLUENT FLOW METERING**

NDEP regulations require that the AWWTP's effluent be metered prior to being discharged for any of the reuse or reclaimed water options discussed in this report including any discharge to the existing wash immediately adjacent to any of the proposed plant sites as shown on Figures 5 through 8. An open reinforced concrete parshall flume structure will be installed downstream of the plant's post aeration basin to meter effluent discharge. Critical flow depth through the flume will be constantly monitored by an ultrasonic sensor to record and transfer discharge flow depth data to the plant's SCADA system in real time.

**SOLIDS HANDLING AND DISPOSAL**

The handling and disposal of secondary wastewater sludge at the AWWTP will be accomplished through the aerobic digestion of raw bioreactor sludge in addition to the utilization of various sludge transfer pumps and sludge dewatering equipment.

Sludge Pumps for Oxidation Ditch Option. Settled solids are typically drawn from the final clarifiers to a sludge pump wet well via telescopic valves. Two (2) submersible pumps with variable speed drives each capable of pumping up to 0.90 mgd will be located in the sludge pump wet well. One pump will be a duty pump with the second pump considered a standby pump if one of the pumps is out of service for required maintenance. These pumps will transfer both Return Activated Sludge (RAS) and Waste Activated Sludge (WAS) to the oxidation ditch and aerobic digesters respectively.

The RAS/WAS pumping rates will be a function of various process-related parameters to effectively waste bioreactor sludge and to maintain optimum levels of mixed liquor within the oxidation ditch bioreactor.

The RAS/WAS pumps along with the telescoping valves will be in a concrete basin located between the two (2) final clarifiers.

Sludge Pumps for Sequencing Batch Reactor Option. Settled solids will be removed from each SBR basin via a WAS submersible pump. Since biological treatment and the separation of solids from the waste stream are performed in the same basin as previously described, there is no need for RAS pumping. Thus all that is needed with the SBR system is a WAS pump in each basin to transfer settled sludge from each SBR basin to the aerobic digestion tanks for further solids processing and ultimate disposal. The

WAS pump in each basin will be controlled by the SBR Programmable Logic Controller (PLC). The operator will be able to set the WAS pump run time so as to maintain optimum levels of mixed liquor within the SBR basin for biological treatment of the waste stream.

Aerobic Digesters. Aerobic digesters are proposed to stabilize waste sludge pumped from either of the oxidation ditch or SBR bioreactor basins. The advantages of aerated digestion include minimal odor or need to burn-off digester (methane) gas, higher quality of effluent, and the indirect facilitation of plant effluent nutrient removal requirements. Disadvantages, as compared with anaerobic digestion, typically include higher power costs associated with blower operations, increased sludge production, and a tendency to be more sensitive to upsets in the upstream microbiological treatment process.

There will be two 223,750 gallon steel glass lined secondary aerobic digesters constructed for each of plant Phases 1 and 2 resulting in a combined total sludge storage capacity of 447,500 gallon at plant build-out. Two (2) digesters will provide for 90 days of sludge storage at a per phase average day plant process flow rate of 1.2 mgd.

Dewatering. It is projected that the stabilized secondary sludge as pumped from either of the two plant digesters will have a percent solids content in the 2.0% to 3.0% range. Secondary sludge with this percentage of solids content typically requires dewatering either through a sludge drying bed process or through the utilization of mechanical dewatering equipment before being transported to either a landfill or land injection site. The latter option is preferred for the AWWTP. Sludge drying beds require considerable surface area that increases the total acreage requirement for a general plant layout scheme and is expected to generate significantly more odor than the mechanical dewatering option.

Two types of mechanical secondary sludge dewatering equipment are currently under consideration for the AWWTP: a screw press or rotary centrifuge. Either of the stated options will produce dewatered sludge cake in the 20% to 30% solids range. A centrifuge generates more noise than a screw press and is more expensive to operate. The decision to utilize either the screw press or rotary centrifuge will hinge on total installation and operational costs in addition to required noise abatement measures within the plant sludge handling building.

Both mechanical dewatering equipment options shall have a minimum processing capacity of 350 dry lbs./hr. at 2% solids.

Disposal. It is projected that dewatered sludge will have a solids content in the 20.0% to 30.0% range which significantly reduces the volume of stabilized secondary sludge to be hauled away to a local landfill as compared with 2.0% to 3.0% partially dewatered sludge from the secondary digesters. Secondary sludge with 20.0% to 30.0% solids can be stockpiled in a fraction of the area needed for drying beds. It is anticipated that dewatered secondary sludge will be hauled to the relatively close





Republic Services operated Regional Landfill at 13550 North State Highway 93 located 9.2 miles southwesterly from the AWWTP site.

The plant's dewatered sludge storage area will provide for approximately six (6) months of dried sludge cake storage.

### **8.3 EFFLUENT DISCHARGE/REUSE**

Effluent discharge from the AWWTP is required to meet NDEP standards for domestic wastewater flow and treatment (30 mg/l BOD, 30 mg/l TSS, and 10 mg/l TKN). This level of effluent quality is considered to be more than adequate for a number of plant effluent reuse options.

The extended general area encompassing the plant site is, for the most part, typical arid desert terrain completely void of any perennial streams that would potentially dictate more stringent plant effluent water quality standards. The area is basically a closed surface water basin. As a result, there appears to be several viable options to reuse, or dispose of, plant effluent:

-  Discharge into the existing dry wash immediately adjacent to the proposed plant site.
-  Discharge into a rapid infiltration and evaporation pond effectively providing some measure of ground water recharge
-  Pursue a contract to provide process or cooling tower water to an industrial business entity with a commitment to construct a building within the AIP.
-  Land application of secondary effluent for xeriscape landscaping or agricultural forage crops.

#### **EFFLUENT DISCHARGE TO AN EXISTING DRY WASH**

Perhaps the most obvious and convenient option is to discharge the AWWTP's secondary effluent into the existing dry wash within the topographic depression immediately adjacent to either of the proposed plant site options as shown on Figures 5 through 8.

The advantages to discharging plant effluent into the dry wash is that there's a reasonable likelihood of the effluent flow completely being infiltrated into the underlying soil profile within less than a mile from the plant outfall. Another advantage is that the existing wash would require very little to no construction work to accommodate the projected 1.2 mgd of average daily flow at build out.

The disadvantage is that the plant effluent would eventually encroach on federal BLM land north of State Highway 93. It is not clear, as of the date of this report, as to the time and effort to acquire BLM approval of the anticipated encroachment.

**RAPID INFILTRATION AND EVAPORATION**

The options to effectively recharge the underlying groundwater aquifer “might” qualify the City of North Las Vegas (CNLV) for some kind of return flow water use credit with the Southern Nevada Water Authority (SNWA). It needs to be noted that return flow credits are usually given to municipalities or wastewater treatment plant owners and operators who discharge treated wastewater directly to the Las Vegas Wash. Accordingly, acquiring return flow credits for the recharge of groundwater underlying the AWWTP is far from a certainty but might be worth the effort by CNLV.

The average annual pan evaporation at the Boulder, Nevada as recorded by the Department of Commerce National Oceanic and Atmospheric Administration (NOAA) is approximately 115 inches per year for the record years of 1970 through 1981. At an average day plant effluent discharge rate of 1.2 mgd, it is roughly approximated that the AWWTP site would need 135 acres for a completely self-contained (no overflow) evaporation pond with the assumption of no soil infiltration losses. A more accurate evaluation of required evaporation pond acreage would require a statistical evaluation of random monthly pan evaporation data of an extended 20 to 30 years of data.

It needs to be noted that there is a reasonable likelihood of a substantial caliche clay layer within the soil profile at either of the proposed AWWTP sites; the extend of which, is not entirely known at this point in the project’s initial planning effort. Conversations with the site engineer involved with the initial construction of the existing Love’s Truck Stop has verified the existence of caliche clay within a few feet of existing ground elevations at the truck stop site. The extent, or scope, of any caliche clay strata at either of the proposed AWWTP sites will have to be evaluated from soil boring operations with the resulting boring logs evaluated by a geotechnical engineer. Depending on the extent of the, yet to be determined, caliche soil strata, the costs to construct a rapid infiltration pond may be infeasible when compared with the aforementioned other effluent reuse options.

**INDUSTRIAL PLANT WATER**

There have been very preliminary inquiries from prospective industrial business entities that have shown interest in building various plants within the AID including the availability of plant process and/or cooling tower water. These inquiries have the potential of turning into very viable long-term water service contracts between industrial business tenants and the CNLV. These inquiries need to be pursued and substantiated during the initial design phase of the project in the event more stringent treatment is required to accommodate any plant or cooling tower water use.

**LAND APPLICATION FOR IRRIGATION OF XERISCAPE LANDSCAPING**

Land application of treated secondary wastewater effluent as irrigation water for xeriscape landscaping is common practice for wastewater treatment plants. It is roughly estimated that the AWWTP would

effectively accommodate 130 acres of total xeriscape landscaping within the AIP. The stated acreage of xeriscape landscaping assumes the implementation of drip irrigation practices throughout the AIP.

## **8.4 ODOR CONTROL**

Odor control measures at wastewater treatment plants typically focus on exposed in-plant water surfaces and a number of areas within a given plant used to collect and store debris from influent flows, sludge storage and processing areas, in addition to the release of digester gas. In short, wastewater treatment plants generate odorous emissions to surrounding ambient air streams from anywhere of numerous locations within any given plant. However, the severity of odor emissions varies from plant to plant depending on the contaminants found within plant influent flows, how a given plant is operated and designed, and local weather conditions.

Influent flows to the AWWTP is expected to be comparable to common domestic wastewater with very moderate to low odor emissions when compared with other similar secondary treatment plants. The obvious significant sources of odor emissions typically include wet influent screen trash and debris stored for long periods of time in open metal trash containers, aerated bioreactor basins, digester gas emissions, and digested sludge storage areas.

Odors from the storage of collected influent screen trash and debris can be mitigated by simply hauling off said trash and debris on a predetermined regular schedule depending on the severity of the odor emissions given the type of trash and debris. Influent screen trash and debris should obviously not be allowed to putrefy. It is recommended that the plant influent screen and grit removal system including all mechanical trash and grit removal/storage equipment be completely housed in a permanent building as one of several low-cost measures that can be utilized to effectively lessen excessive odor emissions from the plant.

The required mixing turbulence in aerated bioreactors generate odors simply given the process taking place by the microbiological and organic waste material hydraulically suspended within the reactor basin. Odors generated from open bioreactors are extremely difficult to mitigate by simply changing plant operations. The only effective way to eliminate odor migration from open bioreactor is to cover the open basin and transport odorous air emissions into some kind of filter or air scrubber system. These filter and scrubber systems can include passing odorous air through sand or soil filters, activated carbon filters, etc. Although these types of odor mitigation systems have proven to be effective, they add significant costs to ongoing plant operations.

Digesters are notorious for odor emissions. Digesters vent digester gas into the open atmosphere and generate tons of wet sludge depending on the size of the plant. Fortunately, the digesters recommended for the AWWTP are aerobic and not anaerobic digesters. Aerobic digesters emit carbon dioxide gas ( $\text{CO}_2$ ) into the open atmosphere as opposed to methane gas ( $\text{CH}_4$ ) mixed with hydrogen

sulfide gas ( $H_2S$ ) for anaerobic digesters. Methane gas is combustible and is usually “torched off” to the atmosphere. Hydrogen sulfide gas is not necessarily combustible but is typically released to the atmosphere with methane gas emissions from anaerobic digesters. The combination of burning methane gas and free hydrogen sulfide can generate considerable air pollution. Carbon dioxide emissions from aerobic digesters are, for the most part, colorless and odorless.

As discussed previously, the secondary digester sludge will be dewatered to roughly 25% total solids content, stockpiled, and hauled to a local regional landfill. The dewatering operation by either a screw press or centrifuge is a relatively odorless operation including the transfer of liquid filtrate or centrate sidewater flows back to the plant headworks or bioreactor basin. However, the storage of sludge cake, even at 25% solids content, is still considered wet enough to generate noticeable odor emissions at an extended proximity from a sludge cake storage or stockpile area. The extent of odor generation from the sludge cake storage or stockpile area is expected to be somewhat amplified by the hot air temperatures with low relative humidity during the summer months of plant operations. Consequently, it’s recommended that the dewatering machinery and/or general sludge dewatering operations including the dewatered sludge storage or stockpile area be fully enclosed in a permanent building to help mitigate excessive plant odor emissions. It is further recommended that stored or stockpiled dewatered sludge be hauled from the plant on an established regular schedule to minimize the volume of stored or stockpiled dewatered sludge to the extent possible.

The need for odor control measures at any wastewater treatment plant is usually dictated by a projection of potential complaints by residential homeowners, employees, clients, and patrons of both industrial and commercial business developments within close proximity of a given plant. The AWWTP will be constructed and operated in an isolated area of Clark County. Accordingly, a considerable level of odor complaints associated with the ongoing operation of the AWWTP is not anticipated with the possible exception of employees and patrons of the Love’s Truck Stop and individuals traveling the nearby US 93 and Interstate 15 highways.

Although there’s an acknowledged potential of odor complaints from truck stop employees and patrons, it is recommended that the AWWTP be designed, constructed, and initially operated without costly odor control measures beyond the recommended housing of the headworks primary treatment and secondary sludge dewatering operations including the dewatered sludge storage and stockpiling area. More costly odor control measures that would include the installation of covers over the plant bioreactor basin and clarifiers in addition to air scrubbing or filtering systems is not recommended for the initial construction of the proposed AWWTP. It is recommended that the CNLV operate the plant for a minimum period of one complete calendar year and take measurements of odor emissions to the immediate surrounding area before making a final decision to incorporate the aforementioned more comprehensive and costly odor control measures at the plant.

## **8.5 INSTRUMENTATION AND CONTROL**

The day-to-day operation of the AWWTP will be done utilizing state-of-the-art supervisory control and data acquisition (SCADA) software as developed by any number of water and wastewater plant software vendors. As a minimum, the plant operator will be able to utilize the SCADA system to both monitor critical plant process parameters and control plant operational equipment from a remote PC. It needs to be noted that all plant operations will be monitored and controlled not only at the on-site plant administration building but also from a remote PC terminal at the CNLV's existing 25.0 mgd wastewater plant located near Nellis Air Force Base.

Plant process parameters will be recorded and monitored by the strategic installation of remote digital sensors sending a continuous data stream to the controlling SCADA system for evaluation and to allow for preprogrammed changes to the ongoing microbiological process conditions within the bioreactor basin. As a minimum, stated remote digital sensors will measure levels of dissolved oxygen and the pH at multiple locations within the bioreactor basin to assure optimization of the activated sludge and tertiary treatment processes. Remote sensors will also read and monitor flow rates throughout the plant for both liquid and solids train operations.

Remote and automated operation of plant process equipment, or systems, will be accomplished by use of programmable logic controllers (PLCs) in conjunction with the SCADA software. The installation of PLCs allows the SCADA software to automatically control process equipment or allow the plant operator to manually control process equipment from the controlling plant PC. The automated SCADA control of plant process equipment will be done in compliance to a strict protocol as programmed into the SCADA software and as dictated and approved of by CLNV wastewater plant operators and process engineers. As a minimum, PLCs will be able to turn on, shut down, or modulate the operation of liquid and solids train pumps; miscellaneous headworks screening, grit removal, and trash/debris removal equipment/systems; blowers; dewatering equipment; solid and liquid train flow valves; etc.

## **8.6 STANDBY ELECTRICAL POWER**

As is obviously the case, NDEP and federal EPA regulations requires that all wastewater plants be designed and operated with standby electrical generators with enough capacity to run critical elements of a given wastewater treatment plant to preclude the possibility of a catastrophic spill of untreated wastewater to the immediate outside environment.

An initial and rough approximation of the AWWTP's electrical power demand indicates that the plant will require at least a 450-500 KW standby electrical generator to power critical components of the treatment plant in the event of a sustained power outage. The generator will be powered by a diesel fueled stationary engine with the generator and engine manufactured as an integral unit housed in a noise insulated and weatherproof enclosure.

## **8.7 ADMINISTRATION / MAINTENANCE BUILDING ARCHITECTURAL AND GENERAL SITE LAYOUT**

As shown on Figure 11, a preliminary floor plan for an administration building at the AWWTP has been completed that includes: operator office, rest room, mechanical room with washer and dryer, entry hallway and garage maintenance bay. A process conformance laboratory is not included in the AWWTP administration building with the assumption that all laboratory tests on plant process liquids and materials will be performed at the CNLV's 25.0 mgd wastewater plant near Nellis Air Force Base.

Although the attached Figure 11 does not include exterior views, building elevations with various architectural treatments will be presented to the CNLV for approval and final incorporation into the final engineering and architectural drawings for the building.

In addition to the floor plan features presented above, the overall plant site will also include a paved public parking lot allowing for a reasonable amount of drive-up visitor and CNLV employee vehicle traffic. The overall plant site will also include a paved operation and maintenance yard to accommodate various maintenance vehicles and equipment including: staff light pickup trucks, sludge hauling 10-wheeled dump trucks, miscellaneous flatbed semi-trucks and trailers to periodically transport heavy process equipment to and from the plant, rubber tired backhoes for general maintenance operations, rubber tired frontend loaders to move and load dewatered sludge, etc. The extended plant yard area will also include a fenced bone yard for the storage of miscellaneous unused plant process equipment or parts in addition to maintenance equipment.

It is also recommended that the plant site be landscaped with appropriate shrubbery, trees and rock that are all conducive to xeriscaping standards, or recommendations, that may be administered by either the CNLV or as recommended by standards established by the Las Vegas Valley Water District. Planted shrubbery and trees can be irrigated by a drip irrigation system utilizing secondary plant effluent.





<b>TABLE 3</b> <b>ESTIMATED PROJECT CONSTRUCTION COSTS</b> <b>OXIDATION DITCH OPTION</b> <b>APEX WASTEWATER TREATMENT PLANT</b> <b>ADF = 600,000 GPD &amp; PDF = 1,200,000 GPD</b>		
Item No.	Description	Estimated Cost
1	Pump Station with Submersible Pumps	\$344,000
2	Headworks Building with Screen & Grit Removal	\$772,000
3	Odor Control	\$37,500
4	Orbal Oxidation Ditch	\$1,065,000
5	2 - Final Clarifiers	\$727,000
6	RAS/WAS Pump Station	\$210,000
7	2 - Aerobic Sludge Digesters Fine with Fine Bubble Aeration	\$523,000
8	3 - Blowers, 1,000 cfm with Building	\$236,000
9	UV Disinfection & Post Aeration Including Tank	\$326,500
10	Mechanical Sludge Dewatering & Building and Storage Area	\$664,000
11	Chemical Storage & Feed Equipment	\$30,000
12	Sludge Transfer Pump	\$14,000
13	Non-Potable Water System	\$85,000
14	New Maintenance/Administration Building	\$485,000
15	Influent/Effluent Automatic Samplers	\$25,000
16	Standby Power Generator for WWTP	\$150,000
17	Electrical	\$750,000
18	Piping	\$545,000
19	Rapid Infiltration Basin	\$672,000
20	Site Work & Fencing	\$400,000
21	SCADA System	\$300,000
	*Tertiary Treatment (Aqua Disc) if Required by NDEP	\$719,000
	Subtotal	\$9080000
	Contingency (15%)	\$1,362,000
	<b>Estimated Construction Cost</b>	<b>\$10,442,000</b>



<b>TABLE 4</b> <b>ESTIMATED PROJECT CONSTRUCTION COSTS</b> <b>SEQUENCING BATCH REACTOR</b> <b>APEX WASTEWATER TREATMENT PLANT</b> <b>ADF = 600,000 GPD &amp; PDF = 1,200,000 GPD</b>		
Item No.	Description	Estimated Cost
1	Pump Station with Submersible Pumps	\$344,000
2	Headworks Building with Screen & Grit Removal	\$772,000
3	Odor Control	\$37,500
4	SBR (Includes Post Aeration Tank)	\$1,548,500
5	2 - Aerobic Sludge Digesters Fine with Fine Bubble Aeration	\$523,000
6	3 - Blowers, 1,000 cfm with Building	\$236,000
7	UV Disinfection	\$273,000
8	Mechanical Sludge Dewatering & Building and Storage Area	\$664,000
9	Chemical Storage & Feed Equipment	\$30,000
10	Sludge Transfer Pump	\$14,000
11	Non-Potable Water System	\$85,000
12	New Maintenance/Administration Building	\$485,000
13	Influent/Effluent Automatic Samplers	\$25,000
14	Standby Power Generator for WWTP	\$150,000
15	Electrical	\$750,000
16	Piping	\$545,000
17	Rapid Infiltration Basin	\$672,000
18	Site Work & Fencing	\$400,000
19	SCADA System	\$300,000
20	* Add if Tertiary Treatment (Aqua Disc) if Required by NDEP	\$929,000
	Subtotal	\$8,783,000
	Contingency (15%)	\$1,317,450
	<b>Estimated Construction Cost</b>	<b>\$10,100,450</b>



TABLE 5 – APEX WASTEWATER TREATMENT PLANT SUMMARY AWWTP ANNUAL OPERATIONAL COSTS OXIDATION VS SBR <sup>1</sup> BIOREACTOR OPTIONS		
Bioreactor Option	Cost Item	Cost
Oxidation Ditch	Common Equipment Power Cost <sup>2</sup> (920k kW/yr. @ \$0.10/kWh)	\$92,000
	Oxidation Ditch Power (500k kW/yr. @ \$0.10/kWh)	\$50,000
	Sludge Disposal (600 Wet Tons/yr. @ \$60/Wet Ton)	\$36,000
	Labor (2 Full Time Plant Operators/Maintenance Staff)	\$100,000
	<b>Total Estimated Oxidation Ditch Annual Operating Costs</b>	<b>\$278,000</b>
SBR	Common Equipment Power Costs <sup>2</sup> (920k kWh/yr. @ \$0.10/kWh)	\$92,000
	SBR Power (270k kWh @ \$0.10/kWh)	\$27,000
	Sludge Disposal (600 wet Tons/yr. @ \$60/Wet Ton)	\$36,000
	Labor (1 Full Time Plant Operators/Maintenance Staff)	\$100,000
	<b>Total Estimated SBR Annual Operating Costs</b>	<b>\$260,000</b>

**Table Notes:**

1. SBR: Sequencing Batch Reactor
2. Common equipment power cost includes: headworks equipment (influent pumps, grit removal chamber pumps, miscellaneous trash/debris handling rakes/augers), blowers (aerobic digesters and effluent post aeration basin), waste activated sludge pumps (Note: return activated sludge pump power costs included in estimate for a specific bioreactor option), UV disinfection panels, and miscellaneous administration building operational costs including all instrumentation and control process-related equipment.



As discussed in previous sections of this report, CNLV is committed to having a wastewater treatment plant completely designed, constructed, operational, permitted, and certified by the NDEP immediately prior to the completion of construction on the new Faraday Future automotive manufacturing and assembly plant within the AIP. As a result of CNLV's stated commitment, the tentative deadline for the completion of the AWWTP is by November of 2017.

To meet the stated deadline, it becomes imperative that CNLV pursue a very aggressive and somewhat unorthodox approach to completing the project's design and construction requirements within the mandatory 18 month time period (May 2016 through September 2017).

As shown in Table 6, the more orthodox **design-bid-build method** of project delivery is estimated to require 33 months to bring the AWWTP fully operational from the date of a notice to proceed with the plant's design. It's therefore apparent that the overall engineering design, construction, and plant startup phases of the overall project needs to be completed in roughly half the time period as would be normally required utilizing the stated design-bid-build method of project delivery.

TABLE 6 – APEX WASTEWATER TREATMENT PLANT PROJECT DESIGN, CONSTRUCTION, AND PLANT STARTUP SCHEDULE <sup>1, 2</sup>	
Scope of Work Item/Task	TOC <sup>3</sup>
Preliminary Site Surveys and Soils Investigations	1
Initial NDEP Approval of Design Criteria	2
Preparation of Construction Drawings & Specifications	8
Public Solicitation of Competitive General Contractor Bids	2
Bid Opening and Award of Construction Contract	2
Project Construction	12
Final Construction Inspection/Issue Notice of Project Completion	2
Plant Startup & Operator Training	4
<b>Total Project Duration Period</b>	<b>33</b>

**Table Notes:**

1. Time of completion estimates are given for individual scope of work items or tasks.
2. Time of completion estimates reflect a "design-bid-build" method of project delivery.
3. TOC: time of completion.




A construction manager at risk (CMAR) approach to project delivery is presented as a viable, and preferred, fast-track solution to complete the AWWTP within the stated mandatory time period.

The CMAR method of construction management was first approved by the 2007 Nevada State Legislature for public works projects with a provision that it will sunset in 10 years. Many Nevada public agencies have implemented CMAR since that time. The major advantages of CMAR is to address



challenges in schedules, budgets, complexity of project, public impact and selecting qualified contractors in an aggressive time frame and thorough manner. The CMAR approach can be selected sometime during the 30%-60% design development stage of a given project based on a combination of qualifications and some pricing elements.

For the AWWTP, the most obvious advantage is schedule in which long lead time equipment can be procured early and the Guaranteed Maximum Price (GMP) can be negotiated and approved prior to final design document development allowing for parallel design and construction activities. Furthermore, the City may take advantage of multiple GMP's or any early release packages to get the CMAR efforts started earlier on specific construction management tasks. Additional advantages to utilizing a CMAR approach to managing a given project's construction efforts include:

-  Qualifications-based selection of the CMAR/Contractor
-  Contractor-provided design phase advantages of:
  - real-time cost estimating
  - specific scheduling and phasing of work
  - value and constructability reviews
-  Open book and continuous pricing

One potential concern with CMAR is verification of project pricing for self-performed work. However, there are many options available to ensure an owner is receiving the best value on this work. Work that is to be performed by sub-contractors will be bid out to pre-qualified firms to ensure competitive pricing.

Additional advantages to incorporating CMAR practices during a given project's construction efforts include a very high success rate with meeting critical project goals such as eliminating the likelihood of missing project deadlines and budget overruns in addition to assuring the highest quality of construction work, a marked reduction with potential construction risks typically associated with unforeseen site conditions, regulatory issues, non-performance of subcontractors, etc. CMAR also allows for improved overall project coordination between the design engineer, CNLV project management staff, general contractor, subcontractors, project inspectors, and all other individuals and/or organizations that can be associated with the completion of an ongoing project.

More specifically, a CMAR project provides a project owner with extensive collaboration with owner's project team members, the development of comprehensive and detailed contract documents, validation of the CMAR GMP process, use of Risk Registry and use of allowances, contingencies and shared savings.

A detailed gantt-bar chart is presented on Figure 12 that presents an overall project schedule by specific engineering and construction tasks with scheduling milestones and/or deadlines. The gantt-bar chart also presents dates and timelines for CNLV project review and status meetings.



As mentioned previously in this report, the timely, design, construction, and startup operation of the AWWTP is a high priority and necessity in order to keep ahead of the planned construction of not only the Faraday Future automotive manufacturing and assembly plant but the probable construction of a number of other industrial and commercial businesses that have expressed interest with constructing buildings and plants within the AIP.

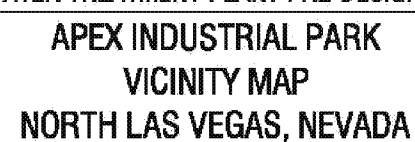
This report has been prepared to provide CNLV with technically viable, cost effective, and industry tested options to design, construct, and operate a wastewater treatment plant that will meet and exceed all environmental regulations as administered by both the NDEP and the federal EPA.

The two basic plant options (oxidation ditch versus sequencing batch reactors) were sized to accommodate a two-phased expansion scheme allowing for each phase to accommodate up to 0.60 mgd of average day flow for a total buildout capacity of 1.20 mgd of average day flow. Average day flow is closely associated with a given plant's process capacity in terms of meeting effluent discharge regulations for both secondary and tertiary water quality standards. The hydraulic or peak day, capacity of the plant was evaluated by applying a peaking factor of 2.0 to the average day flow. Accordingly, the hydraulic-peak day, plant flow capacity has been calculated at 2.40 mgd. The hydraulic-peak day flow capacity is of primary importance with the design of the plant's headworks facilities and sizing of primary treatment equipment including the influent lift pumps. The stated flow capacities are considered to be adequate for all development within the AIP for a 20 to 25 buildout period.

A recommendation to pursue the design and construction of either the Oxidation Ditch or SBR process option at the AWWTP can only be based on an objective comparison of initial construction and annual operation and maintenance costs in addition to the ability of each process option to effectively treat the expected contaminant loads within sanitary sewer flows as generated from a large and diverse commercial and industrial park.

As mentioned in the previous sections of this report, any effort to estimate either contaminant or hydraulic loadings for the AIP is exceedingly difficult given the absolute random and unpredictable nature of the operations that can be associated with any given commercial or industrial business venture looking to build some kind of plant at AIP. Accordingly, whatever process option is selected for implementation at the AWWTP, it needs to be capable of effectively treating a reasonable range of both contaminant and hydraulic loading rates.

It is felt that either of the two process options evaluated in this report (Oxidation Ditch or SBR) would be more than adequate to effectively treat the expected hydraulic and contaminant loading from the AIP. The construction and annual operational costs for both process options are very comparable and within a plus or minus 15% contingency factor. However, the SBR plant option appears to be slightly more cost effective than the Oxidation Ditch plant option.





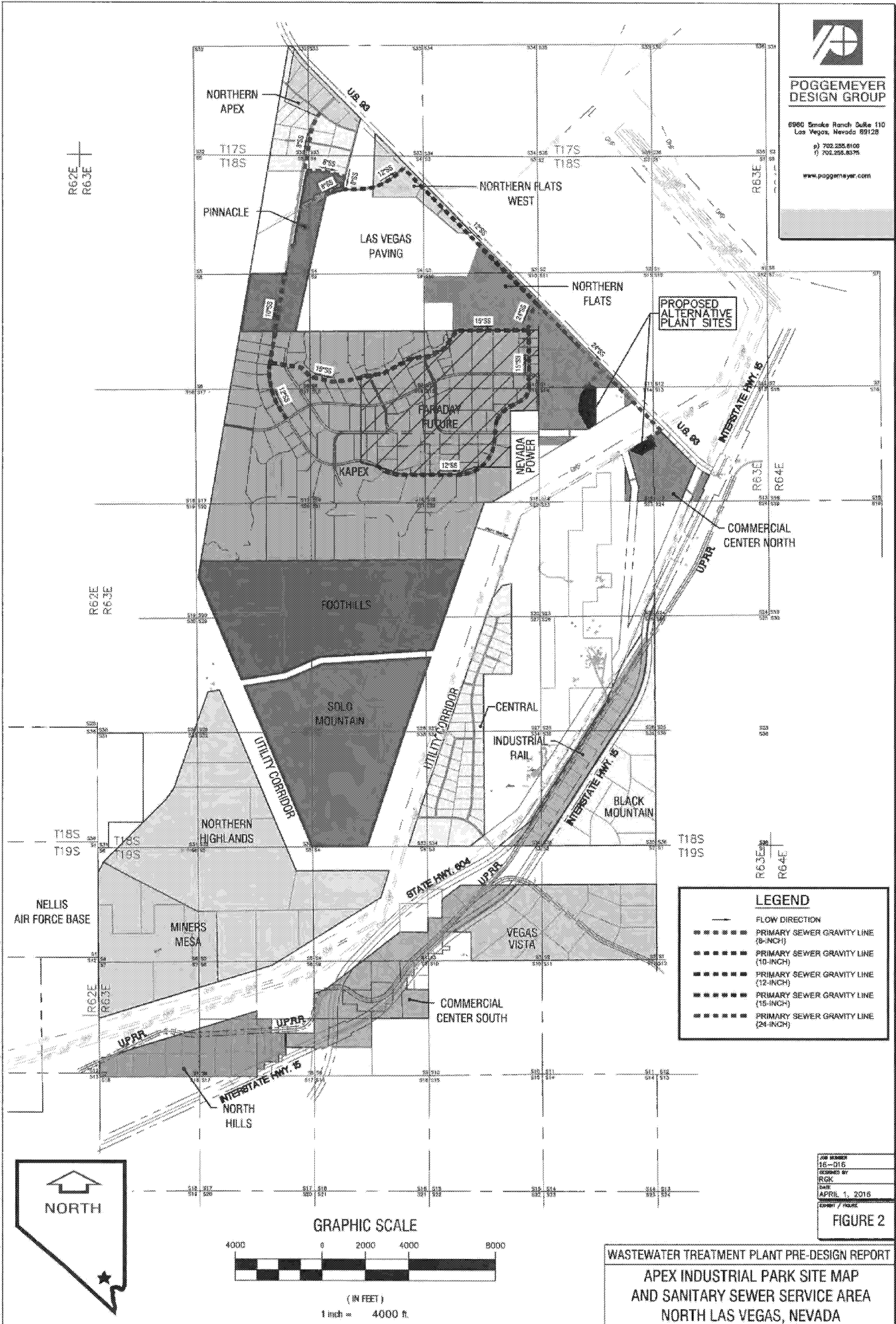


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DESIGN GROUP**

8986 Smoke Ranch Suite 110  
Las Vegas, Nevada 89128

p) 702.255.8100  
f) 702.255.8375

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**LEGEND**

- FLOW DIRECTION
- PRIMARY SEWER GRAVITY LINE (8-INCH)
- PRIMARY SEWER GRAVITY LINE (10-INCH)
- PRIMARY SEWER GRAVITY LINE (12-INCH)
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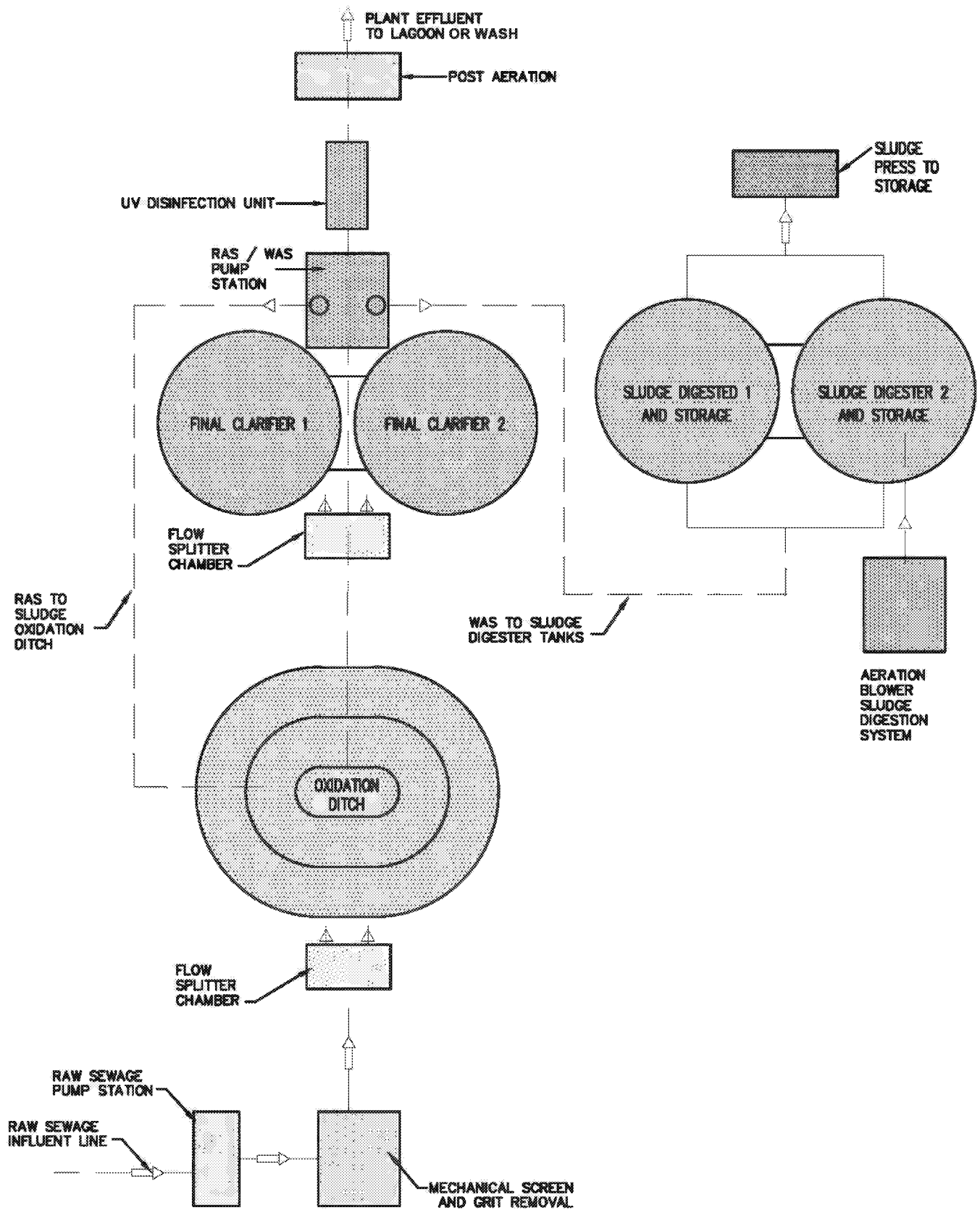
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DESIGNED BY  
RDK  
DATE  
APRIL 1, 2018  
COPIED / PLOTTED

**FIGURE 2**

**WASTEWATER TREATMENT PLANT PRE-DESIGN REPORT**  
**APEX INDUSTRIAL PARK SITE MAP**  
**AND SANITARY SEWER SERVICE AREA**  
**NORTH LAS VEGAS, NEVADA**

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REFERENCE:  
ACAD DWG  
M. ATHERINE  
09/29/2016

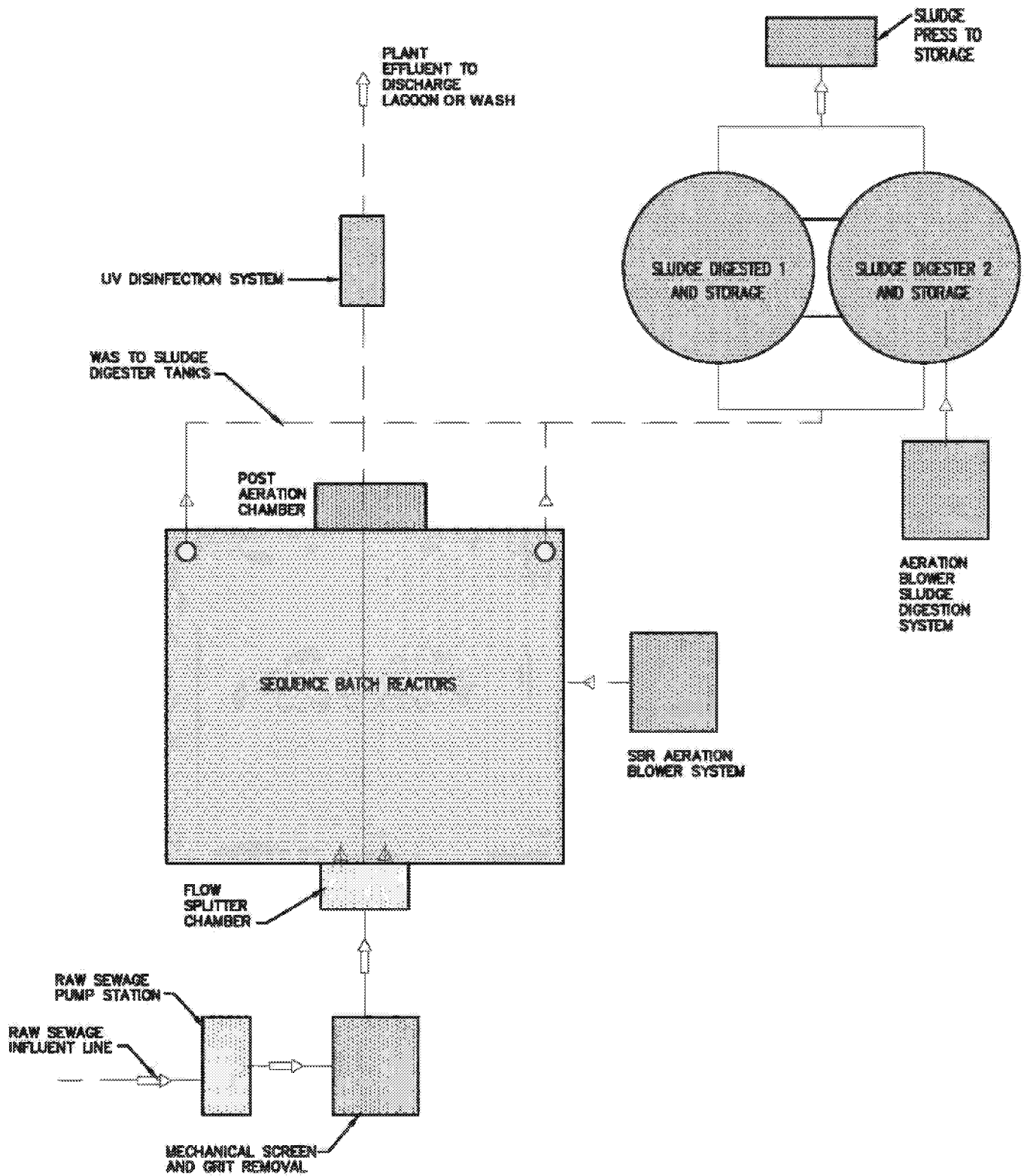
JOB #6364-062

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# OXIDATION DITCH BIOLOGICAL TREATMENT PROCESS ALTERNATIVE 1

FIGURE 3  
APEX WWTP  
PRE-DESIGN REPORT





REFERENCE:  
ACAD DWG  
M. A. HERINE  
08/29/2015

JOB #6384.DWG

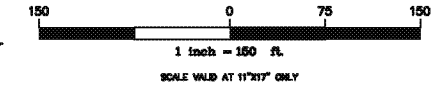
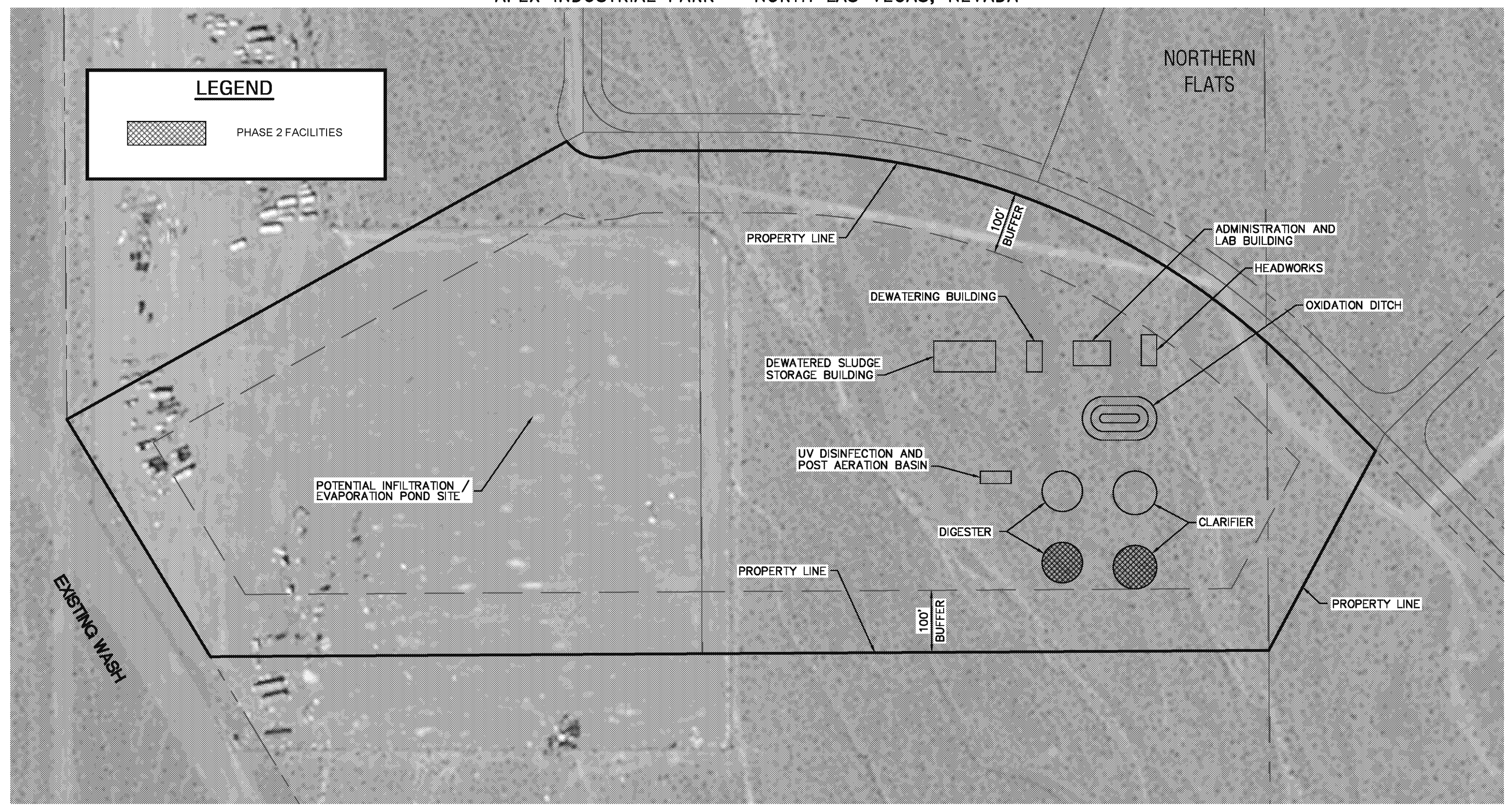
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# SEQUENCE BATCH REACTOR BIOLOGICAL TREATMENT PROCESS ALTERNATIVE 2

## FIGURE 4 APEX WWTP PRE-DESIGN REPORT



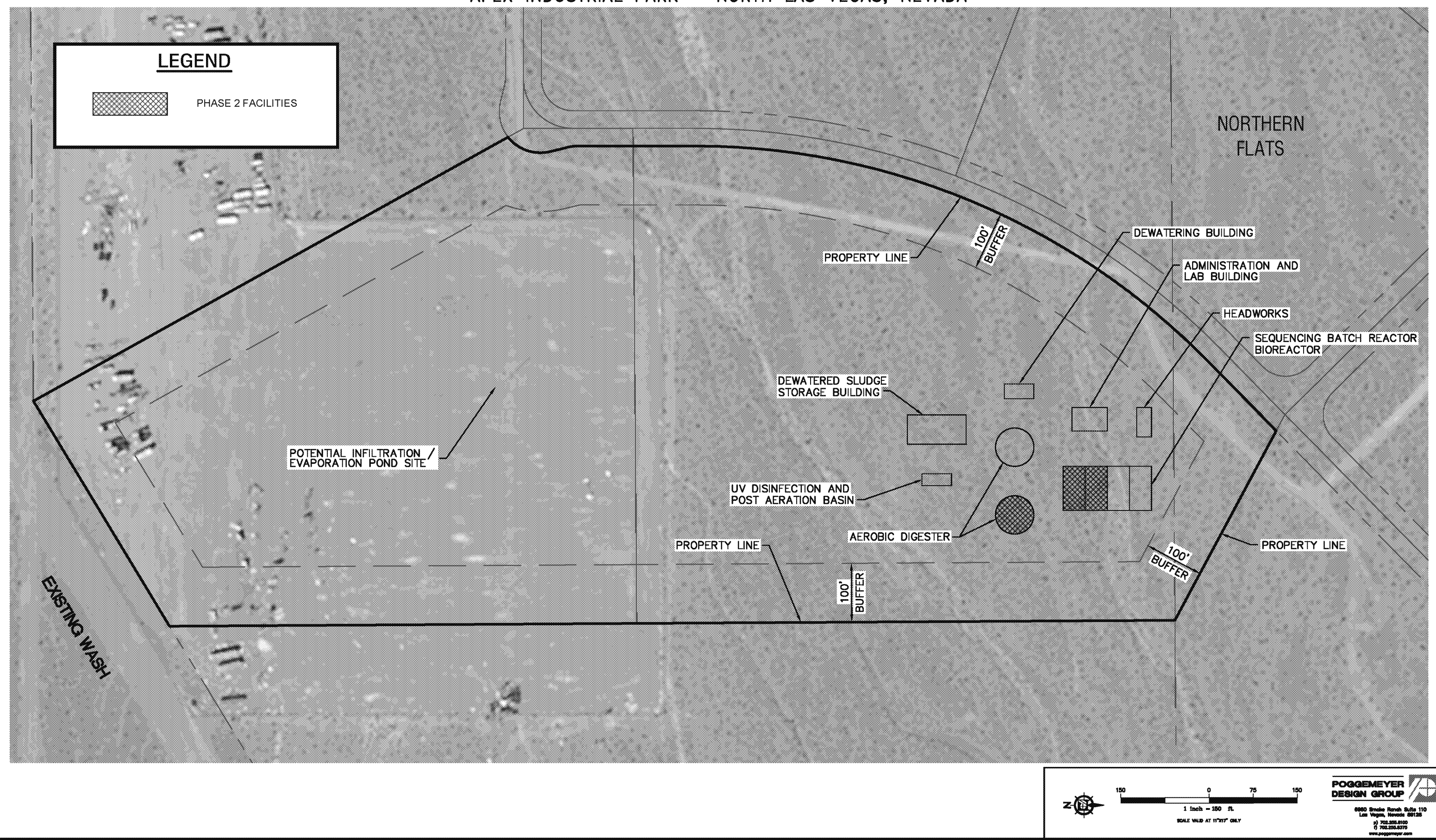
**FIGURE 5**  
OXIDATION DITCH LAYOUT FOR SITE 1  
WASTEWATER TREATMENT PLANT PRE-DESIGN REPORT  
APEX INDUSTRIAL PARK – NORTH LAS VEGAS, NEVADA



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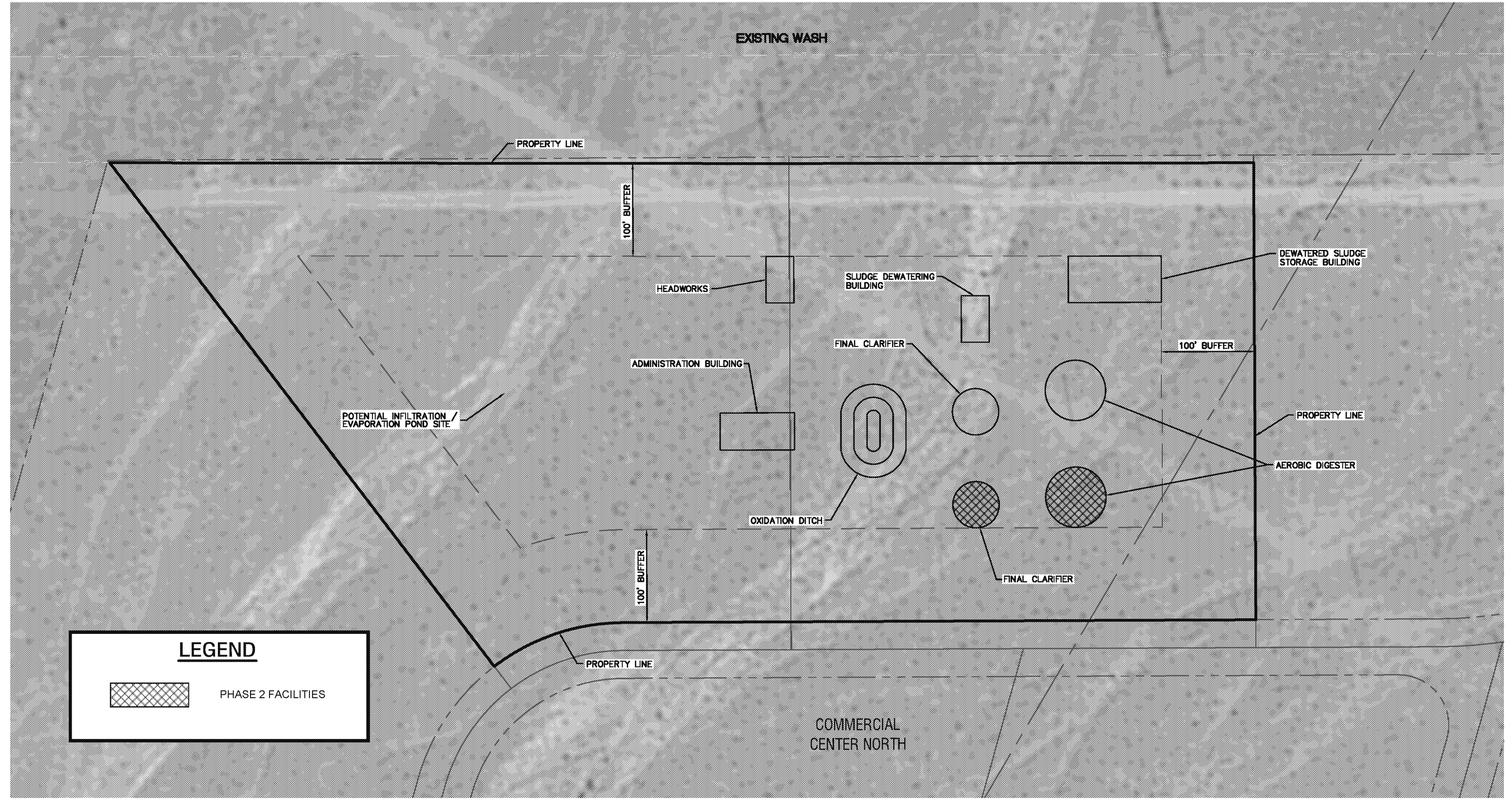
8980 Smoke Ranch Suite 110  
Las Vegas, Nevada 89138  
p) 702.355.8100  
f) 702.355.8375  
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**FIGURE 6**  
SEQUENCING BATCH REACTOR LAYOUT FOR SITE 1  
WASTEWATER TREATMENT PLANT PRE-DESIGN REPORT  
APEX INDUSTRIAL PARK – NORTH LAS VEGAS, NEVADA







**FIGURE 7**  
OXIDATION DITCH LAYOUT FOR SITE 2  
WASTEWATER TREATMENT PLANT PRE-DESIGN REPORT  
APEX INDUSTRIAL PARK – NORTH LAS VEGAS, NEVADA



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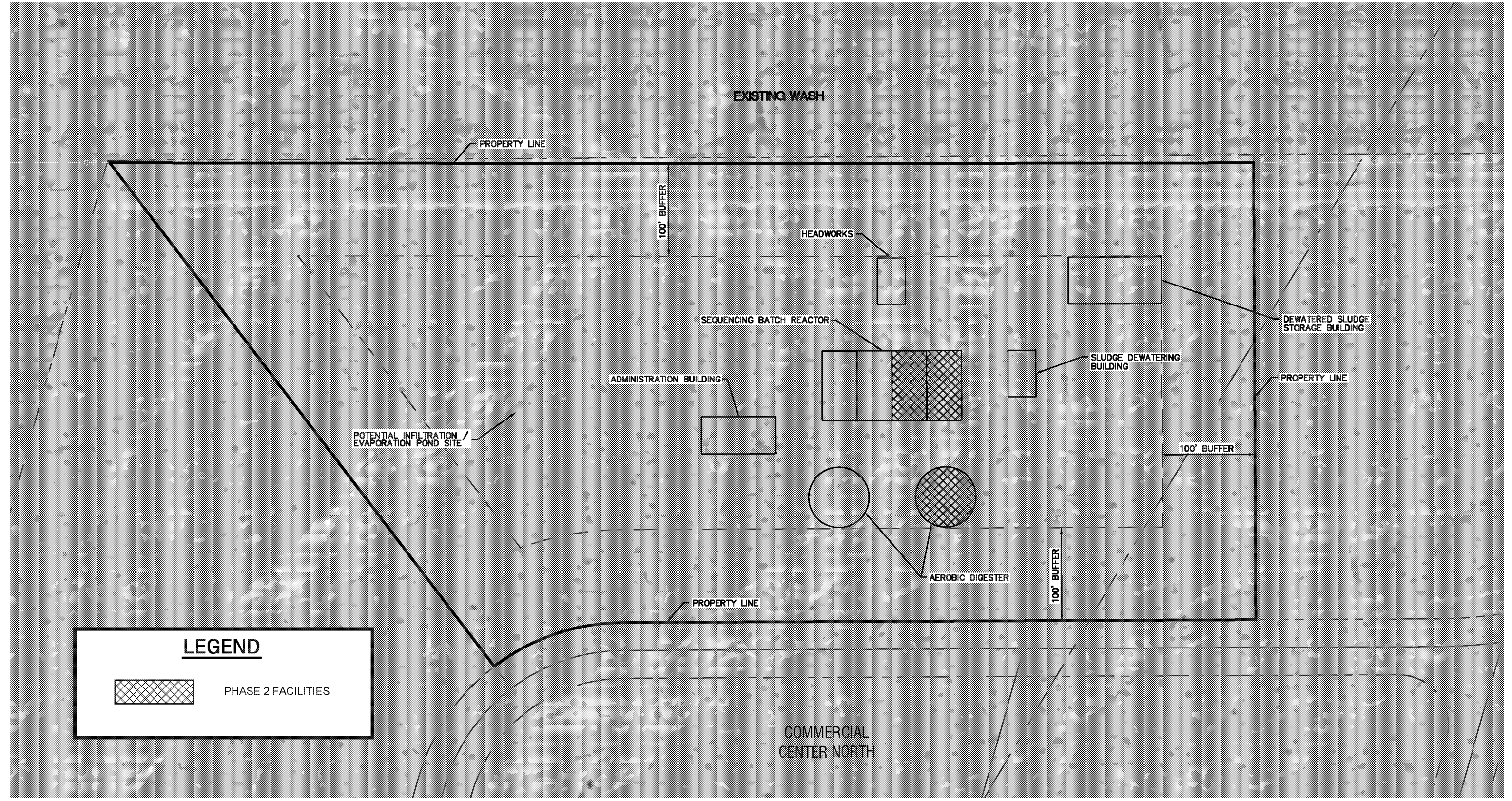
 PHASE 2 FACILITIES



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8880 Smoke Ranch Suite 110  
Las Vegas, Nevada 89135  
p) 702.355.8100  
f) 702.355.8375  
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**FIGURE 8**  
SEQUENCING BATCH REACTOR LAYOUT FOR SITE 2  
WASTEWATER TREATMENT PLANT PRE-DESIGN REPORT  
APEX INDUSTRIAL PARK – NORTH LAS VEGAS, NEVADA



**LEGEND**

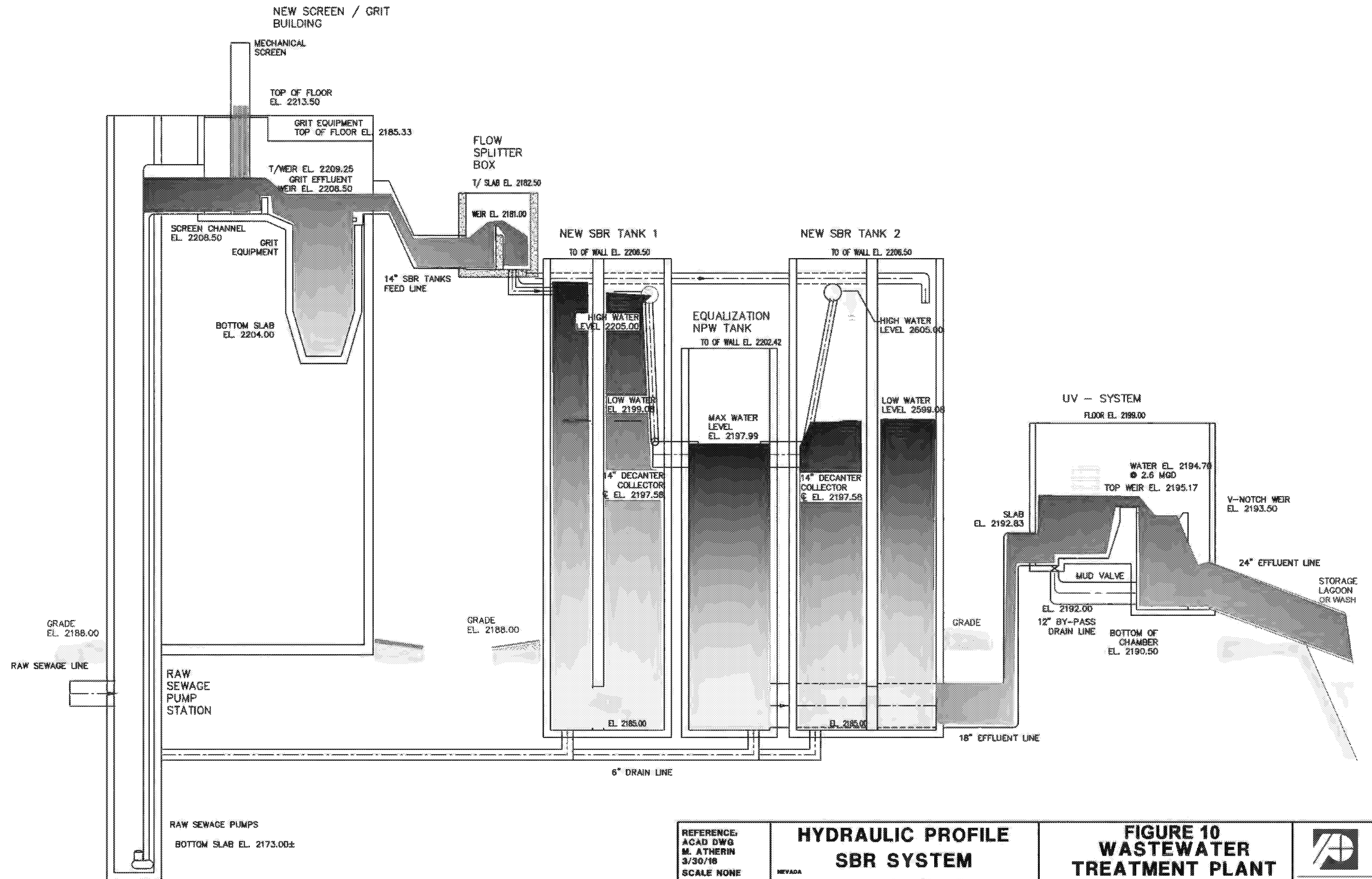
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8880 Smoke Ranch Suite 110  
Las Vegas, Nevada 89135  
p) 702.355.8100  
f) 702.355.8375  
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M. ATHERIN  
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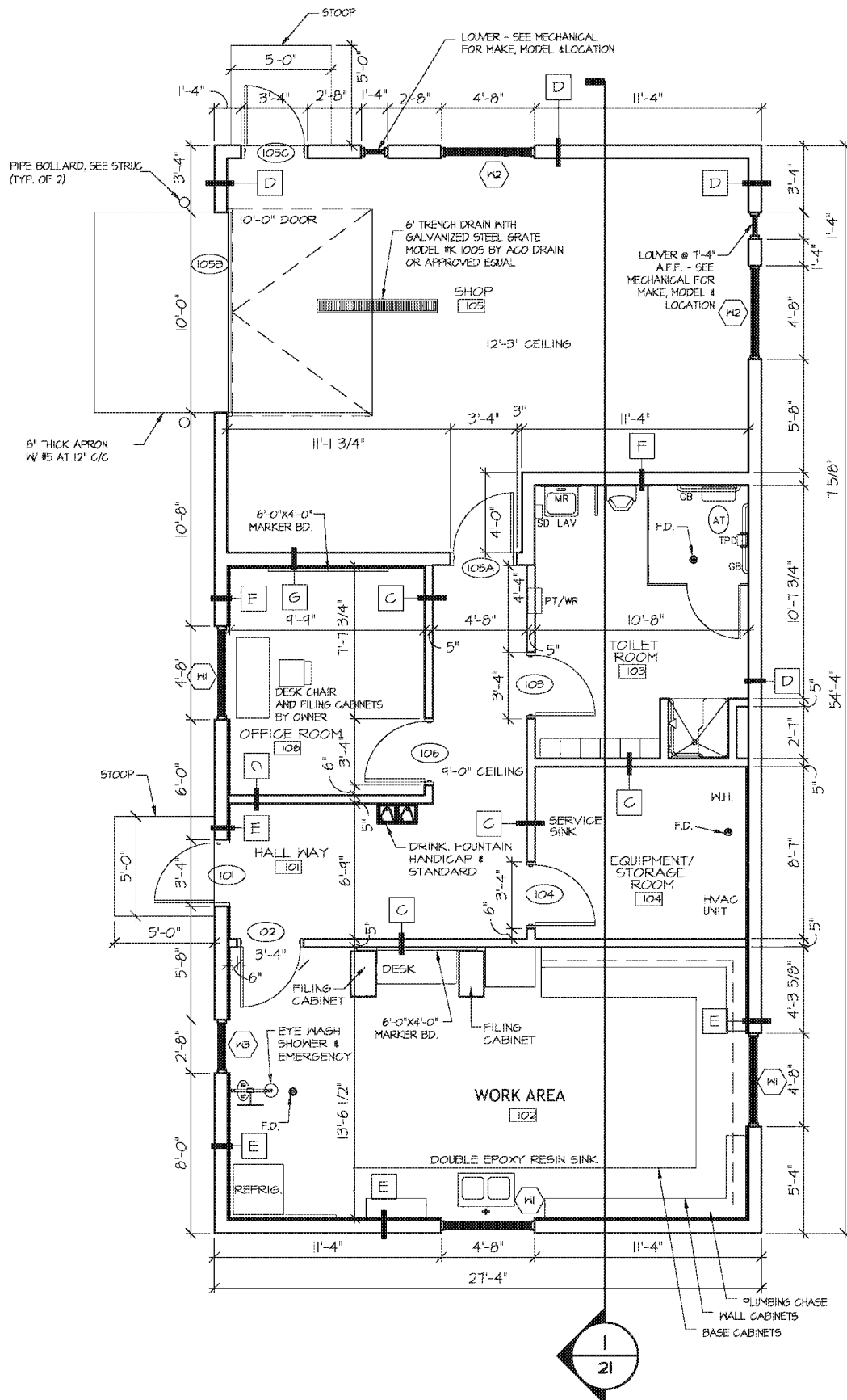
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# **HYDRAULIC PROFILE SBR SYSTEM PLATE FIVE**

# **FIGURE 10 WASTEWATER TREATMENT PLANT STUDY**







REFERENCE:  
ACAD DWG  
M. ATHERINE  
03/29/2016

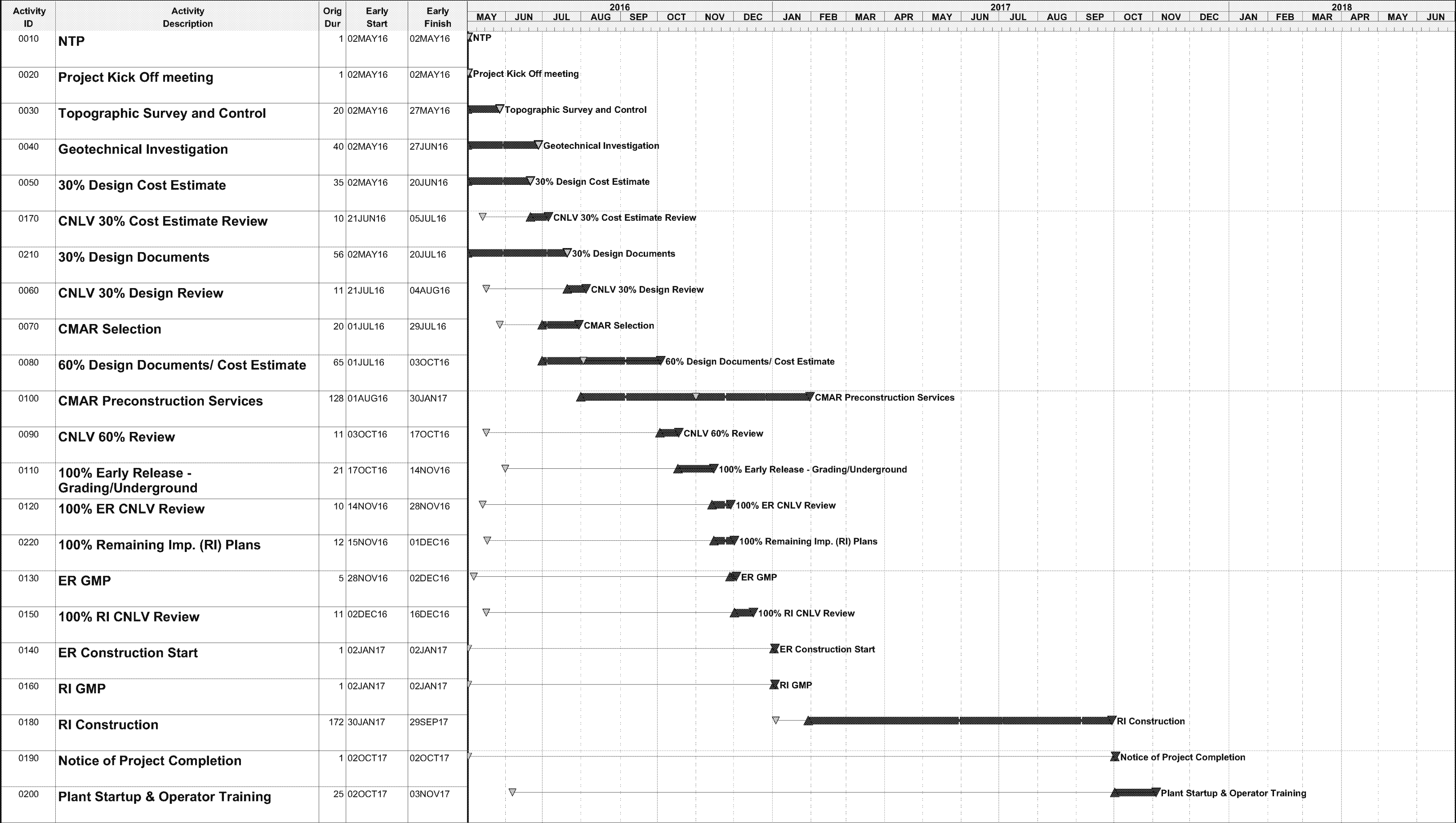
JOB #6384-062

## ADMINISTRATION BUILDING FLOOR PLAN

## FIGURE 11 APEX WWTP PRE-DESIGN REPORT



POGGE MEYER  
DESIGN GROUP



# APPENDIX A

## AWWTP HYDRAULIC CAPACITY EVALUATION



**Apex WWTP**  
**Wastewater Flow Projection and Treatment Plant Sizing**  
**Appendix Item ??**  
Inputs highlighted yellow

This document presents the calculations for projected wastewater flow through the Apex Wastewater Treatment Plant and establishes the buildout and phase 1 biological design capacity and hydraulic design capacity of the WWTP.

Methodology

1. Wastewater flow projection is based on the amount of water supply/demand.
2. It is assumed that 10% of the water demand will be consumed and 90% will go to sewer as average day flow.
3. Biological treatment capacity is based on an assumed influent concentration
4. Hydraulic capacity of the plant is based on a peak factor applied to average day flow.

Water Supply/Demand

The Apex Industrial Park Wastewater Master Plan used a CNLV approved annual water demand as follows.

Average Day Water Demand= 0.5 AF/acre/year Source: Apex Industrial Park Water and Wastewater

The average day water demand is equivalent to:

446.4 Gallons/Acre/Day

To Sewer Factor

It is assumed the amount of water supply that goes to sewer is as follows.

To Sewer Factor= 90% Source: Conservatively assumed

Buildout Average Daily Flow Wastewater Volume Generated

The table below presents the average day water demand and sewage volume generated.

Industrial Park	Buildout Acreage (acres)	Average Day Water Demand (gpd)	Average Day Sewage Volume Generated (gpd)
Mountain View	514.0	229,434	206,491
Northern Flats	733.6	327,457	294,711
ACCN	172.6	77,043	69,339
Pinnacle/N Apex	650.3	290,274	261,247
Other (Faraday/MVIP)	600.0	267,822	241,040
Northern Flats West	103.4	46,155	41,539
<b>Total</b>	<b>2773.9</b>	<b>1,238,185</b>	<b>1,114,367</b>

Buildout WWTP Average Day Flow

Calc. average day flow= 1,114,367 Source: From calculation above

Design average day flow= 1,200,000 Conservatively elected based on calculated average day flow

Buildout ERU Equivalency

1 ERU= 90000 gallons per year Source: DCSWCS Section 1.2.7  
ERU Count= 4056 Calculated

Buildout Peak Flow Rate

Design Avg Day Flow= 1,200,000 gpd Source: From above

Peak Factor= 2 unitless Source: Historical data for Tahoe Reno Industrial

Peak Flow = 2,400,000 gpd Calculated

Buildout Peak Wet Weather Flow

Given the fact the collection system is all new and constructed with gasketed joints, assume infiltration is negligible

Phase 1 WWTP Average Day Flow

Based on a buildout average day flow of 1.2 MGD, the phase 1 design capacity is established as 600,000 gpd based on expected near term development in the industrial park and the ease of doubling the biological treatment capacity and hydraulic capacity when required.

Phase 1 ERU Equivalency

ERU Count = 2,433

Calculated

Phase 1 Peak Flow Rate

Avg Daily Flow= 600,000

gpd

Source: Rationale provided above

Peak Factor= 2

unitless

Source: From above

Peak Flow = 1,200,000

gpd

Calculated

Phase 1 Peak Wet Weather Flow

Given the fact the collection system is all new and constructed with gasketed joints, assume infiltration is negligible

Phase 1 WWTP Treatment Capacity

Biological Capacity= 600,000

gpd

At 200 mg/L influent BOD concentration

Hydraulic Capacity= 1,200,000

gpd

For liquid unit processes

Buildout WWTP Treatment Capacity

Biological Capacity= 1,200,000

gpd

Calculated

Hydraulic Capacity= 2,400,000

gpd

Calculated

**CONCLUSIONS**

Phase 1 Treatment Capacity = 600,000

gpd

Phase 1 Hydraulic Capacity= 1,200,000

gpd

Buildout Treatment Capacity= 1,200,000

gpd

Buildout Hydraulic Capacity= 2,400,000

gpd

Note:

The hydraulic capacity will be used to size the following unit processes in the oxidation ditch alternative:

- a) Influent pumping
- b) Headworks including fine screen and grit removal
- c) Secondary clarifiers
- d) Tertiary Treatment
- e) Disinfection

Note: The biological process will be sized based on design BOD loading.

# APPENDIX B

## NDEP INDUSTRIAL CONTAMINANTS REQUIRING PRETREATMENT PROGRAMS



**Attachment A  
Priority Pollutants**

<u>BASE NEUTRAL EXTRACTIBLES</u>		<u>VOLATILE ORGANICS</u>		<u>PESTICIDES</u>		<u>ACID EXTRACTABLES</u>		<u>METALS</u>		<u>DIOXINS</u>		<u>OTHER</u>	
Storet Code	Name	Storet Code	Name	Storet Code	Name	Storet Code	Name	Storet Code	Name	Storet Code	Name	Storet Code	Name
34551	1,2,4-Trichlorobenzene	34506	1,1,1-Trichloroethane	39310	4,4-DDD	34621	2,4,6-Trichlorophenol	01268	Antimony	34675	2,3,7,8-TCDD	00948	Asbestos
34536	1,2-Dichlorobenzene	34516	1,1,2,2-Tetrachloroethane	39320	4,4-DDE	34601	2,4-Dichlorophenol	00978	Arsenic	00720	Cyanide, total		
34346	1,2-Diphenylhydrazine	34511	1,1,2-Trichloroethane	39300	4,4-DDT	34606	2,4-Dimethylphenol	00998	Beryllium				
34566	1,3-Dichlorobenzene	34496	1,1-Dichloroethane	39330	Aldrin	34616	2,4-Dinitrophenol	01113	Cadmium				
34571	1,4-Dichlorobenzene	34501	1,1-Dichloroethylene	39336	Alpha-BHC	34586	2-Chlorophenol	01118	Chromium				
34611	2,4-Dinitrotoluene	32103	1,2-Dichloroethane	34361	Endosulfan I (alpha)	03615	2-Methyl-4,6-dinitrophenol	01119	Copper				
34626	2,6-Dinitrotoluene	34541	1,2-Dichloropropane	39338	Beta-BHC	34591	2-Nitrophenol	01114	Lead				
34581	2-Chloronaphthalene	34546	Trans-1,2-Dichloroethylene	34356	Endosulfan II (beta)	70012	4-Chloro-3-methylphenol	71901	Mercury				
34631	3,3-Dichlorobenzidine	77163	1,3-Dichloropropene (mixed)	39350	Chlordane (Technical)	34646	4-Nitrophenol	01074	Nickel				
34636	4-Bromophenyl phenyl ether	34576	2-Chloroethyl vinyl ether	34198	Delta-BHC	39032	Pentachlorophenol	00981	Selenium				
34641	4-Chlorophenyl phenyl ether	34210	Acrolein	39380	Dieldrin	34694	Phenol	01079	Silver				
34205	Acenaphthene	34215	Acrylonitrile	34351	Endosulfan sulfate			00982	Thallium				
34200	Acenaphthylene	34030	Benzene	39390	Endrin			01094	Zinc				
34220	Anthracene	32104	Bromoform	34366	Endrin aldehyde								
39120	Benzidine	32102	Carbon tetrachloride	39344	Gamma-BHC (Lindane)								
34526	Benzo(a)anthracene	34301	Chlorobenzene	39410	Heptachlor								
34247	Benzo(a)pyrene	85811	Chloroethane	39420	Heptachlor epoxide								
34230	Benzo(b)fluoranthene	32106	Chloroform	34671	Aroclor (PCB) 1016								
34521	Benzo(g,h,i)perylene	32105	Dibromochloromethane	39488	Aroclor (PCB) 1221								
34242	Benzo(k)fluoranthene	32101	Bromodichloromethane	39492	Aroclor (PCB) 1232								
34278	Bis(2-Chloroethoxy) methane	34371	Ethylbenzene	39496	Aroclor (PCB) 1242								
34273	Bis(2-chloroethyl) ether	34413	Bromomethane	39500	Aroclor (PCB) 1248								
34283	Bis(2-Chloroisopropyl) ether	34418	Chloromethane	39504	Aroclor (PCB) 1254								
39100	Bis(2-ethylhexyl) phthalate	34423	Dichloromethane	39508	Aroclor (PCB) 1260								
34292	Butyl benzyl phthalate	34475	Tetrachloroethylene	39400	Toxaphene								
34320	Chrysene	34010	Toluene										
34556	Dibenzo(a,h)anthracene	39180	Trichloroethylene										
34336	Diethyl phthalate	39175	Vinyl chloride										
34341	Dimethyl phthalate												
39110	Di-n-butyl phthalate												
34596	Di-n-octyl phthalate												
34376	Fluoranthene												
34381	Fluorene												
39700	Hexachlorobenzene												
34391	Hexachlorobutadiene												
34386	Hexachlorocyclopentadiene												
34396	Hexachloroethane												
34403	Indeno(1,2,3-cd)pyrene												
34408	Isophorone												
34696	Naphthalene												
34447	Nitrobenzene												
34438	N-Nitrosodimethylamine												
34428	N-Nitrosodi-n-propylamine												
34433	N-Nitrosodiphenylamine												
34461	Phenanthrene												
34469	Pyrene												

Note: Priority Pollutants shall be analyzed using approved Environmental Protection Agency (EPA) Methods, and/or an appropriate combination of these methods to verify compliance with applicable water quality standards.

2/24/2010

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# APPENDIX C

## NOAA PAN EVAPORATION DATA FOR LAS VEGAS, NV





**Table 8.** Total monthly, total annual, and average monthly Lake Mead evaporation, 1953–95.

[Historical references for this table are U.S. Geological Survey, 1961–64, 1965–75, 1976–82; Hendricks, 1964; Frisbie and others, 1983–85; Pupacko and others, 1988, 1989a, 1989b, 1990; Bostic and others, 1991; Garcia and others, 1992; Hess and others, 1993; Emmett and others, 1994; Clary and others, 1995; and Bauer and others, 1996. Symbol: —, no data available]

Total evaporation, in inches													
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1953	4.1	4.4	4.7	6.2	8.6	8.0	7.6	10.6	8.8	7.3	6.5	6.9	83.7
1954	4.3	3.6	5.9	5.5	8.3	8.3	9.8	9.6	8.4	8.2	5.5	6.1	83.5
1955	5.0	4.2	5.4	7.0	7.3	7.9	9.3	8.1	10.5	7.3	7.6	4.6	84.2
1956	4.1	4.8	5.2	5.9	7.9	9.5	9.3	11.5	7.8	9.1	7.9	5.8	88.8
1957	3.8	2.6	4.8	6.0	6.2	8.3	8.9	10.7	7.6	7.7	8.2	5.7	80.5
1958	4.9	2.7	4.9	4.0	8.1	9.5	10.5	9.6	9.5	8.6	6.5	4.3	83.1
1959	4.2	3.8	5.1	5.1	8.1	8.4	9.6	9.5	9.8	8.0	6.1	5.7	83.4
1960	3.6	4.6	4.6	6.0	7.0	9.0	9.4	11.9	7.1	7.3	5.8	5.6	81.9
1961	3.5	3.7	5.0	5.0	8.2	9.1	9.8	9.0	9.9	8.2	6.3	4.7	82.4
1962	4.5	3.2	6.0	4.2	8.0	8.0	10.2	11.0	8.8	9.2	5.4	4.6	83.1
1963	5.5	3.9	4.7	6.4	7.2	8.0	10.6	10.2	7.5	6.6	7.0	5.4	83.0
1964	5.2	4.8	5.0	6.0	4.6	7.4	10.2	9.3	8.7	6.3	7.1	4.9	79.5
1965	3.4	3.8	4.0	4.2	6.3	7.1	7.9	9.7	9.4	5.2	5.0	4.9	70.9
1966	4.6	3.6	4.1	6.4	6.8	8.0	10.1	10.0	7.4	7.2	5.5	5.2	78.9
1967	4.5	3.5	5.5	6.2	5.6	6.7	7.8	7.6	9.0	8.4	5.1	7.0	76.9
1968	4.0	2.3	4.3	5.8	6.8	7.5	7.0	7.5	8.1	7.7	7.6	6.9	75.5
1969	3.4	3.2	4.3	6.1	5.8	8.5	6.9	8.8	7.8	9.2	5.6	5.6	75.2
1970	4.2	3.1	4.6	5.9	6.8	6.4	7.5	7.3	10.1	9.5	6.8	5.6	77.8
1971	4.3	4.5	5.0	6.3	6.2	7.5	7.8	8.2	10.6	7.7	6.0	6.8	80.9
1972	4.2	2.9	4.2	6.2	7.4	7.5	9.4	8.3	7.9	7.3	5.8	6.8	77.9
1973	4.5	2.2	3.3	4.3	5.7	8.1	11.1	10.5	10.0	8.6	7.5	5.2	81.0
1974	3.6	4.3	4.3	5.6	7.4	7.1	9.4	7.4	8.6	8.9	5.6	7.4	79.6
1975	5.7	6.3	5.6	5.7	6.6	9.2	10.8	12.6	6.9	11.5	9.1	4.8	94.8
1976	3.8	3.6	5.1	5.7	5.2	9.7	8.5	10.6	7.4	7.5	6.0	6.0	79.1
1977	4.1	3.4	5.7	4.4	6.1	6.0	9.4	9.6	9.7	6.5	6.4	4.2	75.5
1978	3.7	3.7	3.4	4.3	6.2	7.9	7.7	10.5	8.6	6.7	5.6	6.8	75.1
1979	4.6	3.3	3.3	4.5	6.5	8.0	8.3	9.0	7.1	9.3	8.1	4.5	76.5
1980	5.1	3.5	4.1	4.0	6.7	7.2	9.4	9.1	6.2	7.9	6.0	3.5	72.7
1981	3.5	2.9	3.2	5.0	4.1	6.9	9.6	6.9	7.7	7.9	5.1	4.9	67.7
1982	3.8	2.3	4.6	3.5	6.5	8.3	6.3	5.8	7.2	6.6	6.4	4.9	66.2
1983	2.4	2.4	3.6	5.6	7.2	8.5	10.3	7.3	5.6	6.5	8.7	3.7	71.8
1984	3.0	3.7	4.4	4.5	5.9	6.5	7.1	6.2	3.8	9.5	5.5	4.9	65.0
1985	3.6	3.7	4.4	3.3	4.8	7.0	7.4	8.4	6.7	5.5	6.4	5.0	66.2
1986	2.8	3.0	3.4	5.6	6.1	5.9	8.0	7.1	9.8	5.9	5.1	6.1	68.8
1987	3.4	3.1	3.8	3.1	5.5	6.6	8.8	7.5	6.8	5.1	3.6	5.6	62.9
1988	3.3	2.1	2.8	3.4	4.7	5.1	6.2	6.2	6.3	4.8	6.8	4.6	56.3
1989	3.5	3.1	4.2	4.5	5.2	4.9	7.6	9.8	4.8	5.2	3.5	5.5	61.8
1990	3.8	3.8	2.7	4.2	7.5	6.8	7.9	8.0	8.4	5.8	7.0	5.8	71.7
1991	2.8	2.0	4.2	2.5	5.8	9.5	8.4	11.2	9.6	9.0	6.9	5.5	77.4
1992	4.1	2.7	2.6	6.0	8.1	5.3	4.7	4.0	3.8	4.2	4.4	2.8	52.7
1993	1.6	3.0	2.4	4.7	8.6	5.1	12.9	9.8	9.4	8.1	9.8	4.7	80.1
1994	4.1	7.3	3.5	5.4	5.4	8.8	9.1	12.7	8.5	8.9	11.2	4.6	89.5
1995	3.2	2.4	2.5	2.6	3.0	8.9	9.3	12.5	—	—	—	—	
Average monthly													
1953–95	3.9	3.5	4.3	5.0	6.5	7.6	8.8	9.1	8.0	7.5	6.5	5.3	76.0
1953–73	4.3	3.6	4.8	5.7	7.0	8.0	9.1	9.5	8.8	7.8	6.4	5.6	80.6
1974–94	3.6	3.5	3.9	4.5	6.2	7.2	8.5	8.6	7.3	7.2	6.5	5.0	72.0
Standard deviation													
1953–73	0.6	0.8	0.6	0.9	1.1	0.8	1.3	1.3	1.1	1.1	1.0	0.8	
1974–94	.9	1.3	.9	1.0	1.1	1.5	1.8	2.3	1.8	1.9	2.0	1.1	